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AMERICAN JOURNAL OF ALTERNATIVE AGRICULTURE

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Volume 12, Number 1, 1997

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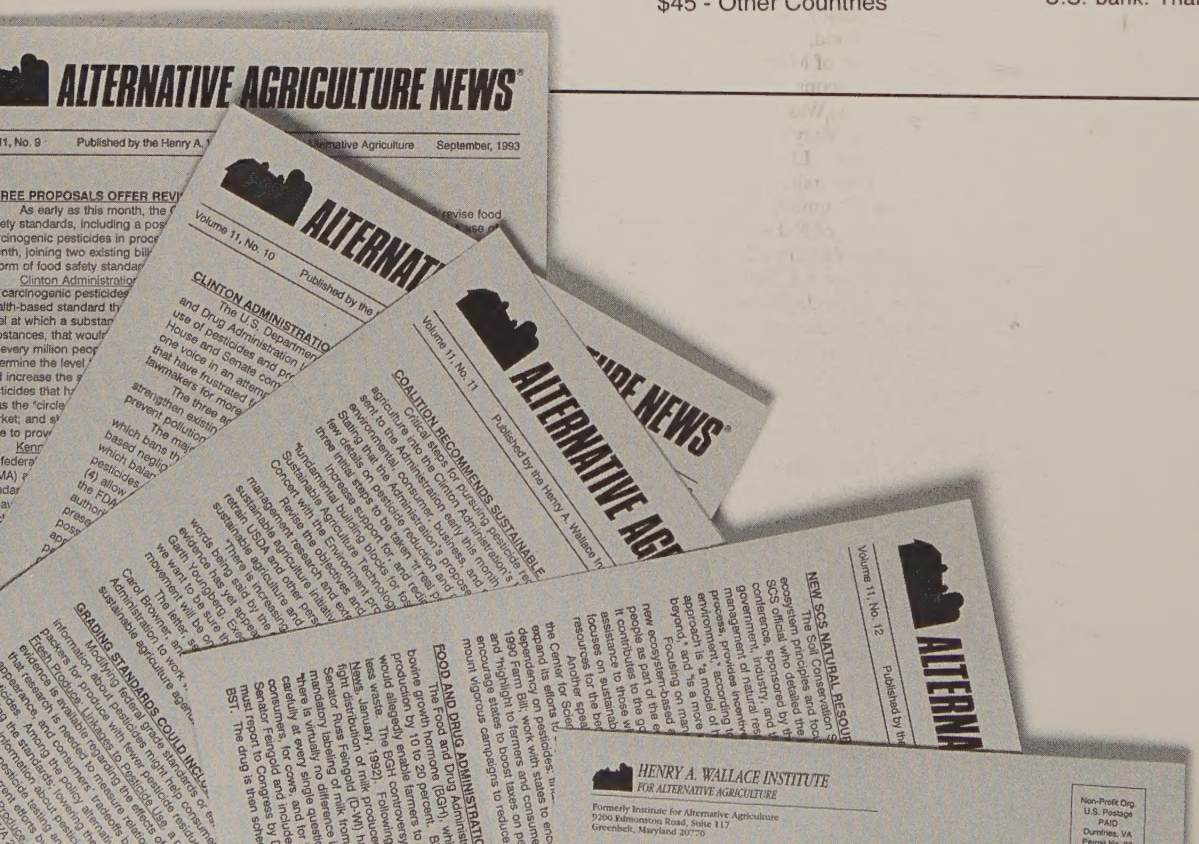

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The American Journal of Alternative Agriculture (ISSN 0889-1893) is published quarterly by the Henry A. Wallace Institute for Alternative Agriculture, Inc., 9200 Edmonston Road, Suite 117, Greenbelt, Maryland 20770-1551, in collaboration with the School of Nutrition Science and Policy, Tufts University, Medford, Massachusetts 02155. Neither the Wallace Institute nor Tufts University is responsible for statements and opinions expressed by authors.

Subscription Information

Annual Journal subscription rates: Library $44—US; $52—Canada and Mexico; $54—all other countries. Individuals $24—US; $27—Canada and Mexico; $28—all other countries. Students $12—US; $13.50—Canada and Mexico; $14—all other countries. Second Class postage paid at Greenbelt, MD. Postmaster: Send address changes to American Journal of Alternative Agriculture, 9200 Edmonston Road, Suite 117, Greenbelt, MD 20770-1551.

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Its programs include providing a national information clearinghouse, serving as a voice for sustainable agriculture in Washington, and developing and implementing research and educational outreach programs. It holds an annual scientific symposium and publishes a monthly newsletter.

The Institute is governed by a grass roots Board of Directors, which includes several commercial-scale organic farmers, and maintains a small professional staff. It is supported by memberships and donations and grants from foundations, corporations, and individuals.

Cover Photo

Wheat being harvested in a farming systems trial at the Rodale Institute Research Center, Kutztown, Pennsylvania. Photo provided by Steven Peters.

Organic versus conventional grain production in the mid-Atlantic: An economic and farming system overview

James C. Hanson, Erik Lichtenberg, and Steven E. Peters

Abstract: *A farming systems trial has been conducted at the Rodale Institute Research Center in Kutztown, Pennsylvania since 1981. Over time, the organic rotation has changed to reflect improved knowledge and experience. The current, three-year rotation (hairy vetch/corn, rye/soybeans, and wheat) focuses on mechanical tillage for weed control and year-round live plant cover for pest control and nutrient supply. We constructed long-term enterprise budgets for the organic and conventional cash grain rotations and compared returns earned during the first years of the study, which for the organic rotation involved investment in soil capital, with returns during two later 5-year periods. The organic rotations during these two later periods produced corn and soybean yields comparable with the conventional rotation, but grew higher-value crops less frequently and required more family labor and management. The differences in the profitability of the conventional and organic farming systems depend on whether the analysis includes the initial investment in building up the soil and the value of family labor.*

Key words: sustainable agriculture, organic grain production, transition costs

There is a widespread perception that contemporary agricultural practices have severely harmed the environment and the natural resource base of agriculture. Farm runoff containing fertilizers and animal wastes is associated with water quality problems in major waterways ranging from the Chesapeake Bay to Lake Okeechobee to the Great Lakes to San Francisco Bay (Just and Bockstael, 1991; Chesapeake Bay Program, 1992; Russell and Shogren, 1994). Nonpoint sources like agriculture account for an increasing share of nutrient pollution, largely because of progress in reducing point source emissions. Contemporary agriculture relies on the use of pesticides, which have been implicated in a variety of environmental problems, including damage to wildlife, poisonings of farm workers and rural residents, and long term health problems like cancers and birth defects (Lichtenberg, 1992). Groundwater contamination from nitrate and pesticides leached from farm land is presently small, but appears to be spreading. For example, a recent survey by the U.S. Environmental Protection Agency (1992) found that over half the nation's drinking water wells contained detectable amounts of nitrate and about 7% had detectable amounts of pesticides, although both pollutants usually were well below health advisory levels. Many parts of the country are prone to soil erosion. Use of heavy machinery also can cause soil compaction and erosion, thus reducing soil productivity. Resistance to pesticides can become significant under heavy pesticide use (National Research Council, 1986; Office of Technology Assessment, 1995).

There has been increasing interest in developing farming methods that are less detrimental to the environment and to the natural resource base of agriculture. These approaches to farming are generally referred to as "sustainable" or "alternative" agriculture. The meaning of the term "sustainable" as applied to agriculture has been debated, but its broad interpretation covers practices that reduce damage to the natural resource base of agriculture and to the environment and human health more generally (for discussions of this issue see National Research Council, 1989; Francis and Youngberg, 1990; Harwood, 1990). For example, the Food, Agriculture, Conservation and Trade Act of 1990 defines the goals of sustainable agriculture as satisfying human food and fiber needs, enhancing environmental quality and the natural resource base of agriculture, making efficient use of nonrenewable and on-farm resources and natural biology, sustaining the economic viability of farm/ranch operations, and enhancing the quality of life for farmers/ranchers and society as a whole (U.S. Congress, 1990).

The acceptability of such "sustainable" farming practices depends largely on their ability to generate acceptable incomes for farmers. Farmers can be persuaded to switch to practices that are more profitable, and they can be persuaded to adopt practices that are more beneficial to the environment if those practices will not reduce their income too much; however, most will not accept large reductions in incomes to grow crops in a more environmentally friendly fashion.

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There is mixed evidence as to whether farmers' incomes are comparable with sustainable and conventional farming methods. Fox et al. (1991) reviewed the literature published between 1975 and 1989 on the economics of farming systems used in North America that fit a broad definition of the term "alternative." They cite roughly two dozen studies of "organic" or "alternative" systems, mainly from the Corn Belt and High Plains. All used budgeting or linear programming with data generated by experimental plots. Many used yield data for sustainable systems based on only one or two years. They could not generalize about the relative profitability of organic and conventional systems or about key factors determining the superiority of one or the other. In a review of several farm level studies comparing sustainable and conventional cropping systems, Lee (1992) notes that net returns and yields tend be lower for the sustainable cropping system but net returns of the two systems sometimes are comparable. In a South Dakota study of row crops, an alternative system appeared to be more profitable than a conventional system and a ridge-till system (Smolik et al., 1995).

Since 1981, the Rodale Institute Research Center (RIRC) has been conducting a Farming Systems Trial (FST) that compares an organic cash grain farming system with a conventional corn (*Zea mays* L.)-soybean (*Glycine max* [L.] Merr.) system in southeastern Pennsylvania. Data from its earlier years have been used in several studies. Domanico et al. (1986) used a programming model to compare the performance of the RIRC system with a representative conventional system. Dabbert and Madden (1986) used a multiyear linear programming model to analyze the economics of transition from a conventional system to the RIRC organic cash grain system. Hanson et al. (1990), using data from the FST for the 1980s, found that while conventional farming was more profitable on average over a ten-year period, the sustainable system was preferred under a safety-first decision rule for risk-averse farmers. In contrast to Dabbert and Madden (1986), who used data only from the early years of the trial, Hanson et al. (1990) found that the sustainable system was more profitable on average after a five-year transition period, suggesting that the greatest costs of a transition to sustainable agriculture may last only through the short run. This notion of a transition is consistent with a natural resource economics view of sustainable systems, which posits agricultural production as involving investament in what one might term "natural capital," which includes soil fertility, soil water holding capacity, and less favorable conditions for weed growth and insect pests. This capital can be increased through crop rotations, green manure crops, biological pest control, and animal manures. Natural capital also can include the skill with which the operator uses these practices. In this view, converting from a conventional to a sustainable system requires a transition during which the farmer builds up (invests in) the stock of natural capital until a long term equilibrium is attained.

This study compared the profitability of the organic and conventional cash grain rotations since 1982. Net returns were calculated two ways: with only cash costs included, such as seed, machinery, and chemicals; and with noncash costs also included, such as unpaid family labor, operator management skills, and the cost of making the transition to an organic system. Since established organic grain rotations for the mid-Atlantic were not available when this study was begun, changes in the organic rotation were made to improve it, for reasons we will explain.

Materials and Methods

The Rodale Institute Research Center is in the Great Valley section of the Ridge and Valley province in southeastern Pennsylvania. The FST is on a gently rolling 25-A site with slopes between 1% and 5%. The primary soil is a Comly silt loam, which is moderately well drained with a perched water table in some locations, and is reasonably fertile. The growing season has 180 frost-free days and 3,000 growing degree days (based on 50°F).

The FST was designed to study the conversion from a conventionally managed to an organic farming system (Culik and Liebhardt, 1984). It was established on land that had been in nearly continuous corn production using chemical fertilizers and pesticides for at least 20 years. The FST features three multiyear rotations: conventional cash grain; low-input cash grain; and low-input with livestock. Research plots were established so that each of the three systems had three different entry points in the rotation (nine treatments), each replicated eight times in a split-plot, randomized block design. In 1986, the FST was modified to focus on the long-term reliability of organic/low-input farming systems and their effect on soil ecology (Peters, 1991; Peters et al., 1992). Yields, input records, and other biological data have been kept for the three FST rotations since its inception, making it one of the few sources of information on long-term performance of sustainable farming systems.

This study analyzes two of the FST's systems: the conventional cash grain and the low-input cash grain. We have chosen to use the term "organic" to describe the low-input system because it is consistent with the guidelines of most organic certification programs in the U.S. The one exception is the use of potassium sulfate, which is sometimes considered a transitional or restricted-use material. The organic production system avoids the use of synthetic fertilizers, pesticides, and growth regulators. Instead, it relies on legumes (green manures and hays) for nitrogen, mechanical cultivation for weed control, and crop rotations, crop diversity, relay cropping and overseeding, crop residues, and year-round live plant cover to achieve adequate soil fertility, soil structure, biological activity, and control of weeds, insects, and diseases.

When the FST was initiated, the organic system was based on the following definition: "An organic system is one which is structured to minimize the need for off-farm soil or plant-focused inputs. Because of the lack of information on the disruptive effects of synthetic inputs, none are used. 'Natural' sources of inputs are used with discretion" (Harwood, 1984, p. 3). The research goal was attainment of a *regenerative* agriculture that would augment the natural resource base of agriculture while providing food and fiber for humankind.

We used data from the FST to model two representative grain farms typical of the mid-Atlantic region. These farms used the cultural practices of the Rodale FST conventional and organic rotations, respectively (Table 1). Yields on each farm were set at 80% of the yields from the research plots to reflect the difference between controlled experimental conditions and field conditions. Both farms were assumed to contain 750 A of tillable cropland. The

Table 1. Crop rotations for organic and conventional systems in Southeastern Pennsylvania, 1981–1995.

	Entry A	Entry B	Entry C
		Organic Rotation #1	
1981	Oats/Red clover	Soybeans	Corn
1982	Corn	Oats/Red clover	Soybeans
1983	Oats/Red clover	Corn	Oats/Red clover
1984	Corn	Wheat/Red clover	Corn
1985	Soybeans	Corn	Oats/Red clover
		Organic Rotation #2	
1986	Oats/Red clover	Barley/Soybeans	Corn
1987	Corn	Wheat/Red clover	Wheat/Soybeans
1988	Barley/Soybeans	Corn	Oats/Red clover
1989	Wheat/Red clover	Barley/Soybeans	Corn
1990	Corn	Oats/Red clover	Barley/Soybeans
		Organic Rotation #3	
1991	Soybeans	Wheat	Corn
1992	Wheat	Hairy Vetch/Corn	Rye/Soybeans
1993	Hairy Vetch/Corn	Rye/Soybeans	Wheat
1994	Rye/Soybeans	Wheat	Hairy Vetch/Corn
1995	Wheat	Hairy Vetch/Corn	Rye/Soybeans
		Conventional System	
1981	Corn	Soybeans	Corn
1982	Corn	Corn	Soybeans
1983	Soybeans	Corn	Corn
1984	Corn	Soybeans	Corn
1985	Soybeans	Corn	Soybeans
1986	Corn	Soybeans	Corn
1987	Corn	Corn	Soybeans
1988	Soybeans	Corn	Corn
1989	Corn	Soybeans	Corn
1990	Soybeans	Corn	Soybeans
1991	Corn	Soybeans	Corn
1992	Corn	Corn	Soybeans
1993	Soybeans	Corn	Corn
1994	Corn	Soybeans	Corn
1995	Soybeans	Corn	Soybeans

conventional grain farm's machinery included equipment for tillage, planting, cultivating, grain harvesting, fertilizer spreading, and spraying. The organic farm had the same machinery complement plus forage harvesting equipment (valued at $24,500 in 1981). Lime applications were custom hired. Each farm was managed by an owner-operator with 250 hours of operator and family labor per month; seasonal labor could be hired by the hour.

We assumed that the farms did not participate in government programs. In particular, the organic cash grain could not have participated before 1990 because of cross-compliance regulations. Moreover, the organic farmer's corn base would decline continuously because of the requirements of the rotation.

The conventional grain farm followed the FST's five-year rotation of corn, corn, soybeans, corn, and soybeans. Three 250-A sections were planted in different entry points, in keeping with the experimental design. Fertilizer and pesticide application rates were made following The Pennsylvania State University's recommendations. The organic grain farm followed the FST's three organic rotations as they changed through the years; three 250-A sections were planted in three different entry points. No pesticides or inorganic fertilizers (except potassium sulfate in 1989 and 1993) were applied to these crops. Both farms received high-calcium limestone when soil tests called for it.

This financial analysis simulates what would have happened from 1982 to 1994 if the representative farms had followed the two rotations with their associated cultural practices. Following Duffy et al. (1989), we dropped 1981 because of start-up problems associated with the FST and a drought that reduced corn yields; the conventional and organic systems suffered equally because of these problems. We developed crop enterprise budgets using FST's inputs and cultural practices, adapted to fit the 750-A farm. Constant input and output prices were used for the entire period. Input prices were representative of the mid-Atlantic region in 1994. Output prices were an average of those received by farmers for the period 1982–1994. We used constant prices to better compare the advantages of each rotation. Variable costs (labor excluded) and fixed costs for machinery were taken from Doane's Agricultural Report (1992). We calculated direct labor requirements using performance data for machinery (hr/A), adjusted upward by 20% to reflect total labor requirements associated with machinery operations (direct plus indirect). Labor requirements were determined by the month using FST dates of machinery operations. We assumed that all labor beyond 250 hours per month was performed by hired labor, paid $9.00/hour.

Various returns were calculated including returns to management (Net Returns III). As in Karlen et al. (1995), "returns to management" is the "residual claimant." As computed here, returns to management includes return to owners' equity and overhead costs associated with buildings. However, these items would not differ between the organic and conventional farming systems, so that differences in Net Returns III can be attributed entirely to differences in returns to management.

Results and Discussion

Agronomic overview

When FST was initiated in 1981, there was little information on organic grain rotations for the mid-Atlantic region. The organic rotation was changed twice over the 15 year period to incorporate agronomic improvements. As a result, no single

organic rotation would allow a straightforward observation of the transition from a conventional to an organic system. However, this learning process is similar to what farmers would go through. In particular, farmers may need to develop new skills for selecting the appropriate crops and equipment, timing field operations, using different ways to increase fertility and control pests, identifying new markets, and other associated management practices. The RIRC made adjustments in the rotation every five years as researchers learned more about the soils and microclimate of the Kutztown area. The principle guiding these changes has been to increase the frequency of cash grain crops in place of the small grain/legume hays and then to provide fertility through winter legume cover crops. Specifically, the following improvements were made in the organic cash grain rotation.

1. Plow under low value legume/hay crops. In the early years (1981–1983, 1985, 1987) the legumes (small grains with red clover) were harvested for hay. This produced extra cash income but also removed organic matter (approximately 1,600 kg/ha dry matter per crop) and nitrogen and potassium (approximately 40–50 kg/ha per crop) which may have been more valuable for use by future crops. After 1987, the decision was made to treat these legumes strictly as a green manure (not harvest as hay) to ensure higher soil fertility/quality.

2. Increase the frequency of cash grain crops in rotation. In 1986, RIRC switched from a five-year rotation to a more intensive three-year rotation. The original rotation had oats/red clover in two years out of five. This grass/legume-based rotation is well suited for improving soil fertility and soil physical properties, but has low economic returns. In the new rotation, soybeans were relay-cropped to improve the profitability. (In relay cropping, soybeans are planted into a standing small grain, whereas in double cropping, a short season soybean variety is planted after the small grain is harvested; both practices yield two cash crops in one year.) Relay cropping also decreases primary tillage (no plowing or disking before planting soybeans), and decreases cultivation for soybeans (no rotary hoeing or row cultivating). Also, tillage was reduced further by overseeding the winter wheat (*Triticum aestivum* L.) into soybeans in the fall, rather than drilling it into a plowed/packed clean seedbed. Both changes were intended to replace mechanical practices (plowing, disking, cultivating) with cultural practices (relay cropping, overseeding), using knowledge of the plant growth habits and agronomic characteristics.

3. Relay cropping too dependent on soil moisture to be reliable. The relay-cropped soybeans yielded well in 1986 and 1987: 38 and 35 bu/A, respectively. However, the success of this technique depends strongly on favorable weather. Lack of early summer rainfall in 1988 led to a soybean crop failure because the barley (*Hordeum vulgare* L.) crop used most of the available water. Excessive rainfall in 1989 caused rank soybean growth that overwhelmed the barley so that it could not be harvested. Favorable weather returned in 1990, but the yields were not as good as in 1986 or 1987. Because this technique was successful in only two years out of five, relay cropping was judged not reliable enough as a cash grain farmer's sole or primary method of producing soybeans. Similarly, overseeding wheat into soybeans was successful in 1987 (seeded in fall, 1986) but unsuccessful in 1988 and 1990 because the wheat stands in early spring were extremely thin from excessive weed pressure. As a result, the wheat had to be plowed down and spring oats (*Avena sativa* L.) and red clover (*Trifolium pratense* L.) planted in its place. Overseeding of wheat also was discontinued.

4. Importance of winter cover crops. The organic rotation was changed to its final form in 1991. In this rotation, corn, soybeans, and wheat are grown over three years. Corn is followed by a winter rye (*Secale cereale* L.) cover crop, which is turned under in the spring and followed by full-season soybeans. After the soybeans are harvested, winter wheat is planted, which is harvested the following July. By not following wheat with short-season soybeans, the farmer can plant a hairy vetch (*Vicia villosa*) crop in late August or early September. Planting the vetch early in the fall aids in overwintering and good production of nitrogen the following spring. The vetch is turned over in the spring and corn is planted. Soybeans and wheat are planted as monocrops into a clean seed bed (as in the 1981–1985 period) in an attempt to increase the chances of a successful cash crop. However, unlike the earlier period, a live plant cover is maintained for almost the entire year to minimize soil erosion and encourage soil biological activity. Instead of broadcasting red clover into wheat, hairy vetch was planted several weeks after wheat harvest in the late summer. Although establishing hairy vetch was more costly than red clover (more tillage operations and higher seed cost), its greater contribution of nitrogen was expected to improve the yield of corn. This rotation, or slight variations of it, has received positive attention from sustainable farmers in the mid-Atlantic region (Hanson et al., 1996).

5. Machinery changes. Besides changing the crop mix of the organic cash grain system, the RIRC also made adjustments in field operations, operating procedures, and equipment. Minor equipment changes were made to control weeds better. For example, a heavier, disk-hiller type cultivator replaced the original S-tine cultivator in 1986, and further modifications were subsequently made to the disk-hiller cultivator. A no-till planter has been used more recently to get more consistent plant populations.

Economic results

Because of the changes in the organic rotation, we could not directly compare the pre- and post-transition periods. We can, however, compare the results of the initial years of the FST with those obtained from the rotations used in each of the subsequent five-year periods. In addition, certain agronomic benchmarks suggest that a transition was completed in 1985. Before 1985 (1982–1984), the yield of organic corn averaged 29% lower than the conventional; in 1985, it was 12% higher; after 1985 (1986 to 1995), it averaged 2% lower. Harwood (1984) implicitly used comparative corn yield as a criterion in his discussion of a transition period. A study of the FST using data envelopment analysis also showed that soil organic matter adjusted to long-term equilibrium levels within three years in the organic rotation (Chambers and Lichtenberg, 1995). Consequently, 1982 through 1984 can be considered the period in which the principal costs of transition were incurred, while the periods 1985, 1986–1990, and 1991–1995 can be considered post-transitional. However, they are distinct, since the rotations used in them differed. This leads us to omit 1985 from the analysis, since the cropping patterns belong to the

initial organic rotation although crop yields and economic returns are post-transitional. As noted above, we follow Duffy et al. (1989) in omitting 1981 from the analysis because of unusual start-up problems.

Table 2 shows net returns per acre for the organic and conventional rotations during these three periods. Table 3 shows the net returns for the organic and conventional rotations on three different farm sizes (based on the 1991–1995 rotations). These comparisons suggest several lessons about the economic performance of the organic rotation compared with the conventional one.

1. The organic rotation can generate total returns per acre comparable to those of the conventional rotation (Table 2). During both 1986–1990 and 1991–1995, Net Returns I (returns to transition cost, unpaid family labor, and management), which is computed by subtracting explicit costs from revenue, was higher for the organic rotation than the conventional one. The difference was greatest during 1986–1990, when the organic rotation earned $13.18/A more than the conventional one. The organic rotation of 1991–1995 also outperformed the conventional one in Net Returns I, earning $6.30/A more.

The advantage of the organic rotation lies in its lower expenditures, which offset lower crop revenues. As seen in Table 2, cash expenditures (seed, fertilizer, lime,

Table 2. Net returns ($/A) for three different periods for an organic cash grain system and conventional cash grain system for a farm with 750 acres of cropland in Southeastern Pennsylvania (constant prices), 1982–1995.

	1982–1984		1986–1990		1991–1995	
	Org.	Conv.	Org.	Conv.	Org.	Conv.
Revenue	163.06	237.46	207.89	236.62	216.26	244.74
Explicit Costs						
Seed	20.25	16.48	27.76	16.66	30.74	18.23
Fertilizer & Lime	0.00	44.08	13.80	36.52	6.60	31.98
Pesticides	0.00	18.37	0.00	32.80	0.00	29.92
Machinery Costs	63.07	60.47	58.75	54.88	65.86	58.07
Hired Labor	5.65	7.04	2.80	4.16	6.93	6.72
Land	50.00	50.00	50.00	50.00	50.00	50.00
Net Returns I[1]	24.09	41.02	54.78	41.60	56.12	49.82
Implicit Costs						
Transition Cost	-	-	6.45	0.00	6.45	0.00
Family Labor Cost	14.34	11.92	15.35	11.10	14.46	10.17
Net Returns II[2]	24.09	41.02	48.33	41.60	49.67	49.82
Net Returns III[3]	9.75	29.10	32.98	30.49	35.20	39.65
Total Labor (hr)	1,666	1,580	1,513	1,272	1,783	1,408
Hired Labor (hr)	471	586	234	347	578	560
Family Labor (hr)	1,195	994	1,279	925	1,205	848
Number of Field Operations/A	9.0	8.4	8.3	7.3	10.1	7.8
Yields (bu/A)						
Corn	74.6	104.9	104.0	106.3	108.8	111.9
Soybeans	39.2	36.5	30.8	30.8	36.6	37.2
Winter Wheat	25.6	-	33.3	-	44.6	-
Oats	49.1	-	77.1	-	-	-
Spring Barley	-	-	33.9	-	-	-
Mixed Hay or Straw (ton/A)	.7	-	.9	-	.6	-
Crop Mix (% of Cropland) (see Table 1)						
Corn	44	67	33	60	33	60
Soybeans	11	33	33	40	33	40
Winter Wheat	11	0	14	0	34	0
Oats	34	0	20	0	0	0
Spring Barley	0	0	w/oc	0	0	0
Mixed Hay or Straw	w/oc[4]	0	w/oc	0	w/oc	0

[1] Net Returns I equals revenue minus explicit costs, and thus represents the return to transitional investment costs, unpaid family labor, and management.

[2] Net Returns II equals Net Returns I minus the transitional investment cost, and thus represents the return to unpaid family labor and management.

[3] Net Returns III equals Net Returns II minus the value of unpaid labor, and thus represents the return to management.

[4] w/oc: grown with other crops

Table 3. Net returns and labor requirements for an organic and conventional cash grain system for three farm sizes in Southeastern Pennsylvania, 1991–95 (constant prices).

	Organic	Conv.
Returns[1] ($)		
	250 Acres of Cropland	
Net Returns I	15,763	14,090
Net Returns II	14,020	14,090
Net Returns III	8,671	9,912
	750 Acres of Cropland	
Net Returns I	42,090	37,366
Net Returns II	37,251	37,366
Net Returns III	26,402	29,736
	1,500 Acres of Cropland	
Net Returns I	74,567	68,241
Net Returns II	63,818	68,241
Net Returns III	51,733	59,471
Labor (hr)		
	250 Acres of Cropland	
Total	594	469
Hired	0	5
Family	594	464
	750 Acres of Cropland	
Total	1,783	1,408
Hired	578	560
Family	1,205	848
	1,500 Acres of Cropland	
Total	3,566	2,816
Hired	2,224	1,842
Family	1,343	974

[1] See footnotes to Table 2 for explanation of Net Returns.

pesticides, machinery costs, hired labor, and land rental) required by the organic rotations averaged roughly $160/A, about 18% lower than the $195/A required by the conventional system in 1991–1995. Revenue was 12% lower for the organic rotation although the organic yield of corn was only 3% less than conventional. The reason was that corn was grown much less frequently in the organic rotation (33% of the time in the organic rotation compared with 60% in the conventional one during 1991–1995). Thus, lower revenue from more lower-value crops is an implicit opportunity cost of the organic rotation.

2. Table 2 also shows that the organic rotations can generate returns that are comparable to those of the conventional rotation after a few years have been spent building up what Chambers and Lichtenberg (1995) term "soil capital." The methodology developed for evaluating the establishment of orchards and other perennial crops is appropriate for evaluating the costs of this transition (Kay and Edwards, 1994). To estimate this cost of investing in soil capital, we treated the reduction in profit experienced from 1982 to 1984 as a loan amortized over 11 years at a 5% real rate of interest. This procedure yielded an estimated investment cost of transition of $6.45/A. Net Returns II (returns to unpaid family labor and management) is found by subtracting this cost from Net Returns I. The advantage of the organic rotation over the conventional rotation in Net Returns II is reduced to $6.73/A during 1986–1990; during 1991–1995, the conventional rotation is $0.15/A more profitable than the organic rotation.

3. Table 2 shows that the organic rotation requires considerably more family labor than the conventional one: 20% more during 1982–1984, 38% more during 1986–1990, and 42% more during 1991–1995. This is similar to results found in four Prairie/Plains states (Minnesota, Iowa, North Dakota, and Montana), where sustainable farmers needed an average of 25% more labor than their conventional counterparts (Northwest Area Foundation, 1994). Family labor in the organic rotations is both greater and more evenly spread throughout the growing season (Fig. 1), although both systems use similar amounts of hired labor (Table 2). The size of these differences in family labor mean that comparisons of profitability that do not take the value of family labor into account seriously misrepresent the relative profitability of conventional and sustainable rotations. As Table 2 shows, valuing family labor at an hourly rate of $9 reduces net returns per acre more for the organic rotations than for the conventional one. Net Returns III (return to management) is calculated by subtracting the estimated value of unpaid family labor from Net Returns II. Measured by Net Returns III, the organic rotation is now only $2.49/A more profitable than the conventional rotation in 1986–1990, and $4.45/A less profitable in 1991–1995.

4. These total labor requirements are similar to the finding of Karlen et al. (1995) that direct labor requirements for an alternative and conventional system in Iowa were 1.90 hr/A and 1.06 hr/A, respectively. Adjusting our total labor requirements to reflect only direct labor (eliminating indirect) shows that the Pennsylvania organic and conventional systems during 1991–1995 required 1.90 hr/A and 1.50 hr/A, respectively.

5. The higher labor requirements of the organic system are a special problem for the increasing number of part-time producers (Fig. 1). It is easy to see why these part-time farmers would choose the conventional rotation over the organic. They can get help planting and harvesting their crops, custom hire their chemical spraying and fertilizer applications, and still keep an off-farm job. During 1991–1995, the conventional producer did not have any field operations from July through September. The opportunity cost that farmers incur in switching from a conventional to an organic system should include any wages and benefits from full-time, off-farm employment that must be sacrificed to pursue the organic rotation. Therefore, the high labor requirements of the organic system may be a significant barrier to its adoption. In contrast, farmers who choose not to pursue off-farm opportunities may find the organic rotation more profitable. That is,

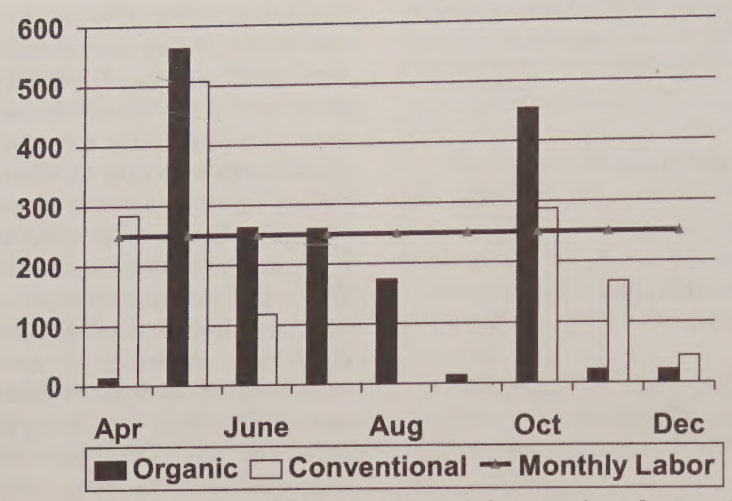

Figure 1. Average monthly labor requirements (hours) for organic and conventional rotations in southeastern Pennsylvania, 1991–1995.

the opportunity cost of the additional labor may be less than the cost of purchased chemical inputs.

6. By presenting Net Returns in three different ways, Table 2 also illustrates how farmers' *perceptions* of profitability vary with their attitudes toward the implicit costs of unpaid family labor and the transition costs, and might help resolve debates over which system is more profitable. For example, during the 1991–1995 period, an organic farmer using Net Returns I as the criterion can argue that organic grain production is more profitable. However, a conventional farmer using Net Returns III as the criterion can argue with equal accuracy that conventional farming is more profitable. Differences in the transition cost farmers face and in how they value family labor may partially explain the conflicting opinions regarding the relative profitability of the conventional and organic systems.

7. Farming sustainably has been said to require more management skills than "just using chemicals." There is an intuitive logic to this statement, in that using biological or mechanical practices to supply nutrients and control pests is probably more difficult than applying inorganic fertilizer and pesticides. However, if true, then the returns to these management skills may not justify the cost of learning them (Table 2). Net Returns III measures returns to management skills. For example, in 1991–1995, Net Returns III is lower for the organic than the conventional, although the management skills required for the organic system supposedly are higher. Of course, this assumes that the only return to learning to farm sustainably is financial. Many growers derive satisfaction from creating environmental amenities on their farms, reducing their exposure to toxic chemicals, eating organically grown food, and other benefits that are more difficult to quantify.

8. As measured by Net Returns I and II, the organic grain rotation becomes less profitable than the conventional rotation as the farm gets bigger (Table 3). Table 3 is based on the 1991-1995 per acre returns in Table 2. These costs all are proportional to farm size, except hired labor (total labor is proportional to farm size). As a result, Net Returns I and II show differences in earnings among farm sizes. On the 750-A farm, as measured with Net Returns I, the organic farmer has a $4,724 advantage over the conventional. Doubling the size of the farm increases the advantage only to $6,326. With Net Returns II, on the 750-A size farm, the organic farmer has a $115 disadvantage; on the 1,500-A farm, this disadvantage increases to $4,423. Net Returns III does not vary proportionally among farm sizes because all labor is valued at $9.00/hr. Fig. 2 illustrates these relationships. Organic Net Returns I is always better than Conventional Net Returns I, regardless of farm size. Organic Net Returns II is equal to Conventional Net Returns II for farms up to 750 A, but falls behind after that. Conventional Net Returns III is always better than Organic Net Returns III, regardless of farm size.

Conclusions

Data from the Rodale Institute Research Center's Farming Systems Trials show that after a short period of investment in soil capital, organic crop rotations can produce per-acre returns competitive with and sometimes greater than conventional grain rotations. In particular, the 1991–1995 rotation (hairy vetch/corn, rye/soybeans, and wheat) has several positive agronomic and economic characteristics. However, further economic analysis suggests that other factors may present significant barriers for adopting sustainable farming methods. The two organic rotations (1986–1990 and 1991–1995) tested in the FST required much more family labor than the conventional rotation. Their higher labor requirements hinder a farmer's ability to continue farming while working full-time off the farm. Therefore, for many farmers the opportunity cost of switching to organic farming (forgone wages and benefits) will tend be high. In addition, the economic costs of investing in soil capital during the initial years may be large enough to tip the balance against organic farming. Thus, individual farmers, especially those with high opportunity costs of labor, may find that future earning potential does not justify the initial investment in soil capital characteristic of organic farming systems. More generally, differences in farmers' perceptions about the relative profitability of organic and conventional farming systems are likely to be strongly influenced by differences in the opportunity cost of labor and transition investment costs.

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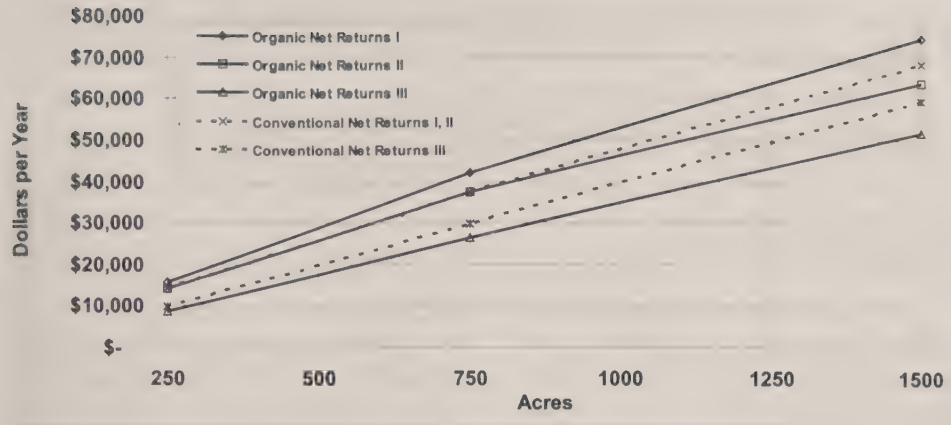

Figure 2. Farm size and comparative returns to organic and conventional rotations.

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Worldwide Fertilizer Use on the Decline

Worldwide use of fertilizer has been declining since 1989, according to *The State of the World 1997,* published recently by the Worldwatch Institute. "Between 1950 and 1989, fertilizer use went from 14 million tons to 146 million tons, a tenfold increase. After 1989, usage began to decline. In many countries, farmers discovered that the amount of fertilizer they were applying was exceeding the physiological capacity of existing crop varieties to absorb and use nutrients." *The State of the World 1997* is $13.95 from Worldwatch Institute, 1776 Massachusetts Ave., NW, Washington, D.C. 20036; (202) 452-1999; e-mail wwpub@worldwatch.org.

Nutrient release from decomposing crop residues in soil: A laboratory experiment

A. Scagnozzi, A. Saviozzi, R. Levi-Minzi, and R. Riffaldi

Abstract. *In a 400-day laboratory experiment, soil was amended with rape, sunflower and soybean residues to monitor the quantitative changes in the main inorganic nutrients. Total N, available P, exchangeable K^+, Ca^{2+}, and Mg^{2+} in all the amended samples increased significantly. Generally, the increase in the amounts of these nutrients was maintained until the end of the incubation period, suggesting that the mineralization of the three crop residues enhanced soil fertility. In amended soil samples, NH_4^+-N disappeared within 14 days, while available N was released as NO_3^--N after 60 days in soybean-treated and after 120 days in rape- and sunflower-treated soil, respectively. Water-soluble P was completely lacking in each treatment because of microbial immobilization and adsorption or precipitation processes in soil.*

Key words: soil amendment, crop residues, essential elements, rape, sunflower, soybean

Introduction

To reduce reliance on industrial fertilizer, innovative farming methods must be implemented. Consequently, there is considerable interest in recycling crop residues to increase soil fertility and supply nutrients for plant growth. Applying residue to soil can change both short- and long-term nutrient availability (Bhat et al., 1991; Douglas et al., 1992; Buchanan and King, 1993; Singh and Singh, 1994). An increased knowledge of crop residue decomposition processes in soil is essential for nutrient cycling studies in agroecosystems.

The quantity of nutrients available in residue-amended soil is influenced by the application rate (Douglas and Magdoff, 1991), the residue's chemical properties, the climate, and interactions among soil microbiota (Buchanan and King, 1993). During the initial stages of residue decomposition, the microbial biomass increases rapidly. Consequently, some major elements, such as N, P, and K, may be immobilized to satisfy microbial metabolism (Wu et al., 1993). For example, in a laboratory study Aoyama and Nozawa (1993) observed that within two weeks after rice straw was incorporated into soil, the inorganic N of the soil had disappeared, whereas the N held in the biomass had increased considerably, showing a rapid immobilization by microorganisms. After the death of the microbial biomass, the immobilized N was remineralized. In a study of immobilization-mineralization and availability of fertilizer N during decomposition of rice straw added to soil, Kanamori and Yasuda (1979) concluded that net mineralization of organic matter takes place when the C:N ratio is about 13 to 14. The dynamics of P turnover are more complex. Singh and Singh (1994) reported a significant increase in plant-available P after incorporation of wheat straw because of an increase in the mobility of phosphate ions and mineralization of organic matter.

Crop residues also are a source of elements such as Ca and Mg. In research on how long-term no-tillage management affects the concentration of some exchangeable bases, Karathanasis and Wells (1990) reported that Ca and Mg in the uppermost surface horizons increased significantly from the accumulation of organic matter in residues.

Rape (*Brassica napus* L. var. *oleifera* D.C.), sunflower (*Helianthus annuus* L.), and soybean (*Glycine max* [L.] Merr.) are economically important in European agriculture; they produce a substantial amount of residues, but only a small amount of research has been conducted concerning their decomposition in soil (Broder and Wagner, 1988; Aulakh et al., 1991; Douglas and Rickman, 1992; Buchanan and King, 1993). The purpose of the present study was to characterize quantitative changes in some soil inorganic nutrients during the decomposition of rape, sunflower, and soybean residues to evaluate their potential value as fertilizer.

Materials and Methods

The soil (2–15 cm depth) used in the experiment was collected from a cultivation area of the Interdepartmental Center "E. Avanzi," University of Pisa, air-dried and passed through a 2-mm sieve. Textural composition of the soil was as follows: clay, 8.3%; silt, 14.8%; and sand, 76.9%. The maximum water-holding capacity (MWHC) was 36%. We collected residues of rape, sunflower, and soybean immediately after harvest from the same experimental area. The crop residues, consisting of the whole-plant aboveground material without seeds, were air-dried, chopped into 2-cm pieces, ground and sieved (<2 mm). We thoroughly mixed 10 g of each residue with 200 g of soil in 400-ml beakers. Deionized water was added to the samples at appropriate intervals to reach and maintain a moisture corresponding to 40% of the MWHC (–45 KPa). Samples, stored at 23±1°C, were analyzed for NH_4^+-N, NO_2^--N, NO_3^--N, and HPO_4^{2-} after 3, 7, 14, 30, 60, 120, 240 and 400 days, and for total N, exchangeable K^+, Ca^{2+}, Mg^{2+}, and available P after 3, 30 and 400 days.

We determined the texture of the soil and the pH of both the soil and the crop

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residues according to SISS (1985); we analyzed organic C, after removing carbonate C (Nelson and Sommers, 1982), by dry combustion (induction furnace 900 CS, Eltra). The total P, K^+, Ca^{2+}, and Mg^{2+} of the crop residues were determined after digestion with concentrated H_2SO_4; P was determined spectrophotometrically and K^+, Ca^{2+}, and Mg^{2+} by atomic absorption spectroscopy. The main chemical characteristics of the soil and of the three crop residues are shown in Table 1. Total N was determined by the Kjeldahl method; NH_4^+-N by distillation of the 2*M* KCl extract (1:10 for soil and crop residue-amended soil; 1:20 for crop residues) (Bremner, 1965); NO_2^--N, NO_3^--N, and HPO_4^{2-} on an aqueous extract (1:5 for soil and crop residue-amended soil; 1:20 for crop residues) by ion chromatography (Dionex mod. 2000i/SP); available P on the 0.5*N* $NaHCO_3$ extract at pH 8.5±0.1 (Olsen et al., 1954); exchangeable K^+, Ca^{2+}, and Mg^{2+} on the 1*N* CH_3COONH_4 extract at pH 7.0 (Thomas, 1982). Again, P was determined spectrophotometrically and K^+, Ca^{2+}, and Mg^{2+} by atomic absorption spectroscopy.

Three containers for each treatment were prepared and incubated according to the selected incubation time. The analysis of variance was performed by the ANOVA test (Snedecor and Cochran, 1978) on the mean value of each parameter. Where the interaction between treatments and time was significant ($p<.05$), a multiple comparison LSD'F-test was performed.

Results and Discussion

Total N in the residue-amended and unamended soils on days 3, 30, and 400 of the incubation period is presented in Table 2. As expected, the incorporation of each crop residue increased total N, but no statistical differences among the various residues were noted. Over the course of the study, total soil N did not change, either in the control or in the residue-amended soil.

Table 3 shows the NH_4^+-N and the NO_3^--N values of the amended and unamended soils. Available N varied considerably during the experimental period depending on the type of crop residue. Ammonium-N in the control was below detectable levels during the experimental period, while the amended soils had low but detectable amounts form during the first 14 days of incubation. The maximum value of NH_4^+-N was found on day 3 in the rape-amended soil, although soybean residue initially had the highest NH_4^+-N content (Table 1). After 14 days of incubation, NH_4^+-N in the amended soil no longer was detectable. This trend, suggesting a progressive immobilization by soil microorganisms, agrees with the findings of Bremer and Van Kessel (1992) and Varco et al. (1993) on the decomposition in soil of several crop residues.

Table 1. Chemical characteristics of the soil and three crop residues (dry matter basis).

Parameters		Soil	Rape	Sunflower	Soybean
Organic C	(g/kg)	6.0	396.0	356.0	407.0
Total N	(g/kg)	0.9	13.0	11.0	14.0
pH		7.8	6.5	9.0	7.1
NH_4^+-N	(µg/g)	-[1]	100.0	100.2	290.0
NO_2^--N	(µg/g)	1.5	-	-	-
NO_3^--N	(µg/g)	7.9	410.0	-	-
HPO_4^{2-}	(µg/g)	-	1700.0	610.0	820.0
Total P	(µg/g)		1900.0	2200.0	1500.0
Available P	(µg/g)	14.0			
Total K^+	($cmol^{(+)}$/kg DM)		67.2	124.3	29.4
Total Ca^{2+}	($cmol^{(+)}$/kg DM)		60.9	119.9	80.9
Total Mg^{2+}	($cmol^{(+)}$/kg DM)		24.0	28.1	34.6
Exchang. K^+	($cmol^{(+)}$/kg DM)	0.5			
Exchang. Ca^{2+}	($cmol^{(+)}$/kg DM)	2.3			
Exchang. Mg^{2+}	($cmol^{(+)}$/kg DM)	1.0			

[1] Dash indicates not detectable.

Table 2. Effect of crop residue amendment on total soil N (g/kg DM) during the incubation period[1].

	Days of Incubation		
Residue	3	30	400
None	0.9b	0.9b	0.9b
Rape	1.5a	1.6a	1.6a
Sunflower	1.4a	1.5a	1.5a
Soybean	1.6a	1.6a	1.6a

[1] Values with different letters indicate significant differences for the entire matrix $p<.05$) according to LSD'F multiple range test.

In contrast to NH_4^+-N, NO_2^--N was detected only in the control and only on days 3 (1.5 µg/g) and 7 (7.3 µg/g) (data not shown). As seen in Table 3, NO_3^--N in the control progressively increased from 7.9 µg/g on day 3 to 85.2 µg/g on day 400, although the values showed no statistical differences until day 120. This increase was due to the mineralization of soil organic matter under the favorable temperature and moisture conditions of the experiment. The incorporation of the crop residues in soil resulted in the complete disappearance of NO_3^--N during the initial steps of their decomposition. This phenomenon, observed by many researchers in studies of crop residue decomposition in soil (Kanamori and Yasuda, 1979; Smith and Peckenpaugh, 1986; Aulakh et al., 1991; Bremer and Van Kessel, 1992; Varco et al., 1993), is due to a temporary immobilization of soil inorganic N by microorganisms. However, in the present study, NO_3^--N appeared by day 60 and day 120 of incubation, indicating a progressive net mineralization of the organic matter added or of the dead microbial biomass. At the end of the experimental period, the NO_3^--N values of the treated soil reached a higher level than that of the control, about 3 times as high in the rape- and the sunflower-amended and 4 times in the soybean-amended soil, respectively.

Water-extractable P also was determined for all the trials (data not shown). It was below the detection limit both in the control and in the amended soils, although it was found in the aqueous extracts of the materials (Table 1). This phenomenon presumably was due both to the immobilization of P by soil microorganisms and to its adsorption processes or precipitation in soil. $NaHCO_3$-extractable P on day 3, 30, and 400 is

Table 3. Effect of crop residue amendment on extractable soil NH_4^+-N and NO_3^--N (µg/g DM) during the incubation period[1].

Residue	Days of Incubation							
	3	7	14	30	60	120	240	400
	NH_4^+-N (µg/g DM)							
None	-	-	-	-	-	-		-
Rape	10.7a	5.8c	5.2c	-	-	-	-	
Sunflower	8.5b	5.2c	4.7cd	-	-	-	-	
Soybean	5.5c	5.2c	3.5d	-	-	-	-	
	NO_3^--N (µg/g DM)							
None	7.9jkl	13.7ijkl	14.8ijk	20.2ij	24.5i	41.1h	79.0g	85.2g
Rape	-	-	-	-	-	6.9jkl	164.2e	259.1c
Sunflower	-	-	-	-	-	15.1ijk	192.2d	277.5b
Soybean	-	-	-	-	4.5kl	101.1f	188.2d	342.1a

[1] Dash indicates not detectable; for each ion, values with different letters indicate significant differences for the entire matrix ($p<0.05$) according to LSD'F multiple range test.

presented in Table 4. Available P in the control remained constant during the experimental period, while it increased because of the incorporation of crop residues in the soil. Among treatments, the highest value of available P coincided with the addition of sunflower residue, although just after 30 days P content decreased in the sunflower treatment and remained constant until the end of the period. The initial increase for each treatment was not proportional to the total P content of the material (Table 1). Rape- and soybean-amended soils showed the same trend as the sunflower-treated soil for 30 days, but their values increased again after 400 days. This phenomenon was probably caused by temporary precipitation or adsorption of P followed by mineralization of organic matter.

Exchangeable K^+, Ca^{2+}, and Mg^{2+} content of the control and the residue-amended soil on days 3, 30, and 400 are shown in Table 5. In the control, K^+ content showed no statistical differences during the experimental period. Crop residue incorporation increased the K^+ content from day 3, with the increase related to the original K^+ content of the three materials (Table 1). Sunflower residue increased soil K^+ content by more than 10 times compared with the control. Subsequently, the K^+ level decreased in both the sunflower- and soybean-amended soils. However, on day 400, it was higher in all the amended-soil samples than in the control. The Ca^{2+} content increased in the soil after incorporation of crop residues, but not in proportion to the materials' original Ca^{2+} content (Table 1). Here, however, the Ca^{2+} content of the rape- and soybean-amended soils showed no statistical differences compared with the control at the end of the experimental period, while the sunflower-amended soil always had the highest Ca^{2+} content. There were no variations in

Table 4. Effect of crop residue amendment on available soil P (µg/g DM) during the incubation period[1].

Residue	Days of Incubation		
	3	30	400
None	14f	14f	14f
Rape	30c	18e	25d
Sunflower	49a	34b	33b
Soybean	33b	20e	27d

[1] Values with different letters indicate significant differences for the entire matrix ($p<0.05$) according to LSD'F multiple range test.

Table 5. Effect of crop residue amendment on exchangeable soil K^+, Ca^{2+}, and Mg^{2+} ($cmol^{(+)}$/kg DM) during the incubation period[1].

Residue	days			Average
	3	30	400	
	K^+ ($cmol^{(+)}$/kg DM)			
None	0.5g	0.7g	0.7g	
Rape	2.3d	2.6d	2.3d	
Sunflower	5.9a	5.0b	4.1c	
Soybean	1.8e	1.7ef	1.2f	
	Ca^{2+} ($cmol^{(+)}$/kg DM)			
None	2.3g	2.6fg	2.7efg	
Rape	4.4c	3.9d	2.9ef	
Sunflower	4.3cd	6.2a	3.9d	
Soybean	5.4b	4.7c	3.2e	
	Mg^{2+} ($cmol^{(+)}$/kg DM)			
None	1.0	1.0	1.1	1.0d
Rape	1.6	1.8	1.7	1.7c
Sunflower	2.3	2.2	2.2	2.2b
Soybean	2.3	2.5	2.2	2.4a

[1] For each cation, values with different letters indicate significant differences for the entire matrix ($p<0.05$) according to LSD'F multiple range test.

Mg^{2+} content during the incubation. However, it was significantly influenced by the type of residue added to the soil, as shown by the fact that the three mean values of Mg^{2+} (calculated as the means of the ion values for each residue at the three different times) were significantly different from one another in proportion to the Mg^{2+} content of the materials (Table 1).

Conclusions

Decomposing rape, sunflower, and soybean residues in the soil promoted the recycling of nutrients and enhanced soil fertility. After residue incorporation, the amount of total N, available P, exchangeable K^+, Ca^{2+}, and Mg^{2+} increased. The disappearance of NH_4^+-N within 14 days of residue incorporation suggests that it is rapidly immobilized by soil microorganisms. The lack of water-soluble P for each treatment during the incubation period could reflect its immobilization by soil microorganisms and its adsorption or precipitation in soil. Evidence of organic matter mineralization resulted from the release of the NO_3^--N after 60 and 120 days, which increased the available N-pool of the soil.

Among the residues tested, sunflower was the most effective in increasing the available P and exchangeable cations. Soybean increased the NO_3^--N content in the soil, after the period of nitrogen immobilization, to a greater extent than the other two residues.

This investigation suggests the need for further studies to evaluate the efficacy of agronomic practices, such as crop residue recycling, for reducing fertilizer use and cost and to slow the leaching of residual NO_3^--N. Long-term laboratory and field studies are needed to reinforce the short-term laboratory data collected in this study.

Acknowledgment. We thank Dr. R. Cardelli for technical assistance. This research was supported by the University of Pisa and the National Research Council (Italy).

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Court Rules EPA Must Disclose Ingredients

A federal district court in Washington, D.C., has ruled that the EPA must disclose the inert ingredients of pesticide products to two environmental organizations, the Northwest Coalition for Alternatives to Pesticides, and the National Coalition Against the Misuse of Pesticides. Inert ingredients include up to 2,300 substances that are added to pesticide products, but unlike active ingredients, are not identified on product labels; manufacturers claim that inert ingredients are a trade secret.

Farm structure, market structure and agricultural sustainability goals: The case of New York State dairying

Rick Welsh and Thomas A. Lyson

Abstract. *This paper explores issues of agricultural sustainability in relation to arguments to sustain the family labor farm and the theoretical justification for the recent increase in smaller-scale milk processors and differentiated dairy product markets. Using a population of New York State dairy farm households, we identified farm structural variables that influence farmers' use of chemical pesticides and fertilizers and their consideration of intensive rotational grazing. Milk sales, division of hired labor on the farm, and ownership arrangements are found to be interrelated and predict relative use of chemical pesticides and fertilizers within a "conventional" confinement feeding system. Marketing strategies predict production practices within a confinement feeding system less reliably but do predict whether the farm has considered adopting an intensive grazing system. Farms that have higher sales, that use hired labor more extensively, and that are not single family operations are more likely to use chemical pesticides and fertilizers. Farms that sell to differentiated markets are more likely to look favorably on an eventual switch to an intensive rotational grazing system.*

Key words: sustainable agriculture, pesticides, niche markets, craft production, mass production, rotational grazing

Introduction

Some analysts have framed the debate over agricultural sustainability in terms of the ecological impact of farming without considering social and economic aspects as central to the argument (Crews et al., 1991; Gillespie, 1995). Others, such as Strange (1988), argue that strengthening a system of family-labor farms is the true vehicle for achieving agricultural sustainability (Gillespie, 1995). According to Strange, small to medium-sized farms are sustainable because they minimize resource use and are critical for the continued vitality of rural communities. Lyson and Geisler (1992) and Lyson and Welsh (1993) add a twist to Strange's argument by asserting that small, flexible production systems that can quickly retool to exploit new markets can lead to a larger number of viable farm-based enterprises, which contributes to sustainability through social, economic and ecological diversity.

Building on these theoretical frameworks, we attempt to provide an integrated foundation on which farmers, activists, policymakers, and academics might build a more sustainable agriculture. We use the concepts of mass production and craft production as key theoretical constructs in this endeavor. The case of the New York State dairy industry is used to illustrate the interrelationships between farm structural variables and farm production practices.

Specifically we examine how farm size, the role of hired labor on the farm, farm marketing strategy, ownership arrangements and production level per unit are related to pest and nutrient management practices and the farmer's attitude toward changing to intensive rotational grazing, an alternative system of feed production. We hope to illuminate the relationships between the organization of on-farm production and the oft-stated goals of those working in the sustainable agriculture movement, such as limiting or eliminating the use of chemical pesticides and fertilizers and promoting low-input alternative production systems. In putting forth our arguments, we do not intend to produce typologies of agricultural production systems, but rather to identify important factors that influence farmers' behavior and ultimately have greater social and environmental ramifications.

Aspects of Mass Production and Craft Production

Lyson and Geisler (1992) describe mass production in dairy farming as large-scale and technologically sophisticated production of a large amount of standardized product with a highly differentiated division of hired labor. Investment in equipment and machinery is high and labor tasks are routinized as much as possible to make workers largely interchangeable and replaceable (Gilbert and Akor, 1988; Lyson and Geisler, 1992), and milk is produced for undifferentiated mass markets (Lyson and Geisler, 1992). Craft production, on the other hand, is characterized by smaller-scale units that rely less on hired labor (Colman and Elbert, 1984; Mooney, 1988) and produce for segmented or niche markets. These markets can be based on several criteria, including the region of production

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or specialized qualities of the product (Lyson and Geisler, 1992).

Historically, agriculture in the United States, including dairying, has moved from a craft-based toward a mass production system (Pirtle, 1926; Selitzer, 1976; Bolter, 1987). The number of very large farms has increased while the number of smaller, family labor farms has dropped dramatically. Also, average farm size has increased and more hired labor is used on the farm. In addition, the markets for dairy products have evolved from a locally based to a large-scale marketing and distribution system (Selitzer, 1976). These widely dispersed markets are becoming increasingly less varied as one breed of cow, the Holstein, overwhelmingly dominates dairy production (Doyle, 1985). Another significant change is the greater reliance on confinement feeding instead of pasture-based systems (Selitzer, 1976).

Several analysts have pointed out that despite these profound structural changes, substantial variation exists within agriculture, both regionally and nationally, and both across and within commodity systems (Mann and Dickinson, 1978; Gilbert and Akor, 1988; Mooney, 1988; Buttel et al., 1990). The research of Lyson and Geisler (1992) and of Lyson and Gillespie (1995) differs from much of the work on structural differentiation by concentrating on the linkages between market structure and farm structure. Dairy farms that cannot take advantage of economies of scale within conventional markets can remain viable by developing and exploiting niche markets that offer value-added opportunities. An important aspect of this strategy is the type of cow used to produce milk. Different breeds of cows produce milk better suited to making different products (Lyson and Geisler, 1992). For mass fluid markets the Holstein is best because of its high production and low butterfat content (Foley et al., 1972; Becker, 1973). In contrast, milk from Jersey cows is high in butterfat and is suited for high-fat products such as cream, butter, and premium ice cream. Also, milk from Jerseys and Guernseys contains carotene, which may cause some consumers to prefer it (Foley et al., 1972).

Gilbert and Akor (1988) argue that larger farms are characterized by a highly complex division of labor, with hired labor performing many specialized farm tasks. Larger size and a complex division of hired labor often is associated with ownership arrangements that are more bureaucratic than single family operations, such as partnerships, limited partnerships, and family and non-family corporations (Bolter, 1987).

On larger, industrial-type farms, higher labor costs necessitate higher production levels to achieve a positive return on investment. High-input, high-output production has been offered as the model to which farms should conform. This mode of operation has been endorsed by firms in the agricultural supply and food processing sectors, the land-grant university complex, and the U.S. Department of Agriculture (Hightower and DeMarco, 1978; Office of Technology Assessment, 1986; National Research Council, 1989; Barlett, 1993).

On New York State dairy farms, this thinking has been associated with increased use of high-energy corn and alfalfa hay to boost milk production. Concurrently, farmers must realize high crop yields to maintain their high milk production schedules. Traditionally, high corn and hay yields have been obtained through the use of chemical pesticides and fertilizers (Selitzer, 1976; National Research Council, 1989).

On smaller farms, labor typically is supplied by family members, who combine family activities and house maintenance tasks with production tasks to sustain the farm (Colman and Elbert, 1984; Gilbert and Akor, 1988). This distinguishes craft-oriented labor from workers employed on large-scale mass production operations.

Dairy farms that for whatever reason have not followed the high-input, high-output strategy frequently find themselves on a production trajectory for which no set of "best management practices" exists. Not surprisingly, craft-oriented dairy farms, through a combination of choice and necessity, construct viable farming systems by relying more on the knowledge gained from their accumulated work experience through a negotiated division of labor and interaction with local ecological conditions (Kloppenburg, 1991; Feldman and Welsh, 1995). They develop locally specific management techniques that rely primarily on household relations and resources to farm according to local ecological, agronomic, social, political, and market conditions. Larger-scale producers, in contrast, can garner resources to purchase inputs, hire labor and construct a bureaucratic organization that relies less on local conditions.

Part of the motivation to retain a craft orientation may be a lack of financial and managerial resources needed to follow a high-input, high-output production strategy (Cruise and Lyson, 1991). However, many farm households choose to follow this path because the mass production path does not suit their values concerning the nature of farming and farm life (Colman and Elbert, 1984; Salamon, 1985; Mooney, 1988; Barlett, 1993).

Dairy Farming in New York State: An Example

Dairy farming is the largest component of New York State's agricultural industry (New York Agricultural Statistics Service, 1993/94). New York dairy production ranks third in the United States behind California and Wisconsin in volume and the value of final products. Because of its importance to the state and national economy, the dairy industry in New York has a well-developed technological and informational support system (Dupuis, 1993). Despite a large decrease in the number of dairy farms in New York State over the past fifty years, there is a great deal of heterogeneity in production practices and farm structure. Some dairy farms have expanded dramatically, requiring substantial amounts of full-time hired labor; others have remained small enough to be run by family labor (New York Agricultural Statistics, 1993/94). Some dairy farmers have chosen or are considering intensive rotational grazing as a way to reduce purchased inputs rather than maximize production (Leonard, 1995). Rotational grazing often is touted as a less energy intensive, more sustainable method of milk production (Liebhardt, 1993). Also, farmers who have adopted it have been cited for greatly reducing their cost of production, which enables them to become more profitable (Leonard, 1995).

New York and other states have seen the number of small scale milk processors increase, including the number of on-farm bottling operations (New York State Department of Agriculture and Markets, 1994; Lyson and Gillespie, 1995). Direct marketing of milk through home delivery has returned in some areas (Mouillesseaux,

1994/95), as have high value markets for specialty cheeses, yogurt and other dairy products (Dupuis, 1993). For all these reasons, New York provides an appropriate context to empirically test whether farm structure and market structure influence the use of on-farm production practices.

Specifically, this research will address the following questions. Are the farm structural characteristics of size, division of hired labor, marketing strategy, ownership arrangements, and production per cow related? If so, how? How well do these farm structural variables predict farmers' pest and nutrient management practices and their willingness to adopt intensive rotational grazing?

Methods

As part of a larger regional research project examining organizational changes in the dairy industry, we developed a questionnaire for New York State dairy farm household members. The questions concerned farm structure, household goals and household characteristics, pest control and nutrient management practices, and attitudes toward adopting intensive rotational grazing. We constructed a mixture of "fill in the blank" and "choose the best possible response" questions, along with open-ended questions. The pest management questions were open-ended. The answers to these questions were tape recorded and transcribed.

We adjusted the survey after testing it on a New York State Cooperative Extension agent, an agent of the Soil Conservation Service, and a dairy farmer in the county. With the assistance of the extension agent we obtained a list of all dairy farmers operating farms in Ontario County in upstate New York.

Farmers were contacted by phone according to their geographic location within the county; that is, selections were made starting from the northeast corner of the county and moving south and west until fifty dairy farm households had agreed to participate. Twenty dairy farmers refused to be interviewed, for an acceptance rate of 71%. The most common reasons given for not wishing to be interviewed were "not wanting to fill out another survey" and "about to retire so not interested." Dairy farmers who agreed were interviewed on their farms. The interviews took from 1.5 to 4 hours, and were tape recorded and transcribed.

Two farmers were dropped from the analysis: one did not grow any crops used to feed the cows, and the other had just begun operations, so did not have a pest and nutrient management history. The final sample had 48 farm households. Our intent was not to survey a large number of dairy farmers. Rather, we thought it important to visit each farm household to be sure of the quality of the data.

The analysis was performed in two steps. The first was to discern which, if any, farm structural variables were statistically associated with each other. The next step was to test the relationship between the farm structural variables and a set of variables that tap the farmers' pest and nutrient management strategies in corn and hay and attitude toward adoption of intensive rotational grazing.

Farm structure variables

- *Farm Size*. Farmers were asked the value of annual sales for the past year. Possible responses were:

  1 = Less than $10,000
  2 = 10,001 to 20,000
  3 = 20,001 to 40,000
  4 = 40,001 to 60,000
  5 = 60,001 to 80,000
  6 = 80,001 to 100,000
  7 = 100,001 to 200,000
  8 = 200,001 to 300,000
  9 = 300,001 to 500,000
  10 = 500,001 to 750,000
  11 = 750,000 to 1 million
  12 = More than 1 million

- *Hired Labor*. Farmers were asked which tasks on a list of 15 dairy production tasks were performed by hired labor.
- *Markets*. Farmers who, through arrangements with their milk buyers, milked herds other than Holsteins or who sold to a local small-scale milk buyer were assigned a value of 1. All other farmers were assigned a value of 0. Breeds other than Holstein included Jersey, Ayrshire, Brown Swiss, Guernsey and mixed breeds.
- *Ownership Arrangement*. Farms owned by a single family were coded as 1; all other ownership arrangements were coded as 0.
- *Milk Production*. Farmers were asked their average milk production, in lb per cow per year.

The means and standard deviations of these variables are given in Table 1.

Table 1. Means and standard deviations of farm structure variables.

Farm Structure Variable	Mean	S.D.
Farm sales	7.83	1.62
Tasks performed by hired labor	6.40	3.69
Market (Differentiated market = 1)	0.15	0.36
Ownership arrangements (Single family = 1)	0.44	0.50
Herd average milk production (lb)	19,040	2,897

Production practices

For the pest and nutrient management practices, our intention was to capture the relative use of synthetic chemicals in the production of the two most common feed crops for dairy cows: corn and hay. All production variables were binary (1 = use of practice; 0 = nonuse). The practices of interest are given in Table 2.

Analysis and Results

We used factor analysis to discern which farm structure variables were statistically related. The principal components analysis resulted in two factors with eigenvalues greater than 1. The first factor explained 46.7% of the variation in the population, the second factor 21.6%. The factors were rotated using a varimax rotation procedure.

The rotated result is presented in Table 3. The absolute value of the variable coefficient determines the relative importance of a variable within a factor; the sign shows the direction of association. In factor one, milk sales has the most impact, followed closely by hired labor and ownership arrangement. Higher sales are associated with a more complex division of hired labor (hired labor performs more tasks) and a more bureaucratic ownership arrangement. In factor two, the dominant variable is type of market, though average milk production per cow also is important.

Factor scores were calculated for each case for each factor. A high factor score indicates a relatively greater representation of the dominant variables within a factor.

Table 2. Farming practice variables.

Farming practice (use = 1)	Mean
Use soil insecticides in corn	0.35
Use herbicides in corn	0.94
Cultivate corn to minimize herbicide use	0.08
Scout corn for insects	0.52
Scout corn for weeds	0.35
Cultural controls for alfalfa weevil	0.65
Use herbicides in hay	0.58
Plow up hay stands when weedy	0.27
Scout hay for insects	0.69
Scout hay for weeds	0.15
Use starter commercial fertilizer in corn	0.98
Side-dress corn with commercial fertilizer	0.62
Use commercial fertilizer on hay seedings	0.90
Top-dress hay with commercial fertilizer	0.81
Adoption of intensive rotational grazing	0.17

Farms with higher scores for factor one on average sold more milk, used more hired labor, and were other than single-family operations. The absolute value of the coefficient for the variable representing average milk production per cow indicates that it is not a substantial part of the first factor. Therefore, in this sample, productivity is not necessarily associated with larger farms that rely extensively on hired labor.

Farm households with higher factor two scores sell to a local market or to markets that value milk from cows other than Holsteins, and have lower herd averages. The latter finding probably is partially due to the fact that the breeds that make up the alternative market variable are well known to give less milk on average than Holsteins.

A farm can have any combination of the two factor scores: the two factors are not correlated. Our intention is not to construct mutually exclusive types of farm households, but to identify important factors within and between farm households that potentially influence environmental performance.

We used logistic regression to discern how the two sets of factor scores varied with the use or nonuse of the selected practices.

Table 3. Factor analysis results, rotated solution.

Farm Structure Characteristic	Factor 1	Factor 2
Farm sales	**.870**	–.085
Tasks performed by hired labor	.766	–.166
Sells to differentiated market	.056	**.911**
Single family operation	**–.752**	.048
Herd average	.443	–.663

Substantial differences (i.e., regression coefficient at least 1.5 times its standard error) regarding at least one of the two factors were found for seven of the fifteen production practices, with factor one a more reliable predictor than factor two. Results for these seven practices are presented in Table 4.

In general, farms with higher factor one scores were more likely to use chemicals to control pests and to boost production of corn and hay. Specifically, there was a strong tendency for farms with higher milk sales, with more extensive use of hired labor and with a more bureaucratic organization to use soil insecticides at corn planting, use herbicides to control weeds in hay, side-dress corn with commercial fertilizer and top-dress hay fields with commercial fertilizer. These farms were less likely to cultivate corn or to plow up weedy hay stands instead of spraying them. Farms that sold to differentiated markets and had lower herd averages were more likely to plow up a weedy hay stand rather than spraying it, were less likely to top-dress hay fields with commercial fertilizer, and were more likely to consider adopting an intensive rotational grazing system.

Discussion and Conclusions

Results from this study provide insight into the family farm and market differentiation perspectives as they relate to issues of agricultural sustainability. Specifically, dairy farms that have increased in scale and moved away from the reliance on family labor and toward a more complex bureaucratic organization also rely more on synthetic chemicals to maximize total production. These findings support the position that family-labor farms are important for developing a productive and sustainable agricultural system.

We also found that farm households that sell to markets based on "alternative" milk characteristics are more likely to consider abandoning the dominant confinement feeding system for a grass-based system. The desire, ability, or opportunity to locate or create alternative markets is more strongly

Table 4. Logistic regression coefficients, with standard errors in parentheses.

Farming practice	Factor 1	Factor 2	Constant	Classified Correctly (%)
Use soil insecticides in corn	.728** (.360)	–.179 (.337)	–.680** (.327)	66.7
Cultivate corn to minimize herbicide use	–1.091* (.612)	–1.085 (1.225)	–3.172*** (.947)	91.7
Use herbicides in hay	.704** (.332)	.071 (.311)	.367 (.310)	66.7
Plow up weedy hay stands	–.540* (.359)	.620* (.332)	–1.112*** (.361)	70.8
Side-dress corn with commercial fertilizer	.785** (.353)	–.273 (.315)	.521* (.324)	66.0
Top-dress hay with commercial fertilizer	1.371*** (.540)	–1.042** (.440)	2.163*** (.602)	87.5
Would consider adopting rotational grazing	.213 (.471)	.956*** (.361)	–1.889*** (.472)	83.3

* coefficient is >1.5 times the standard error
** coefficient is >2.0 times the standard error
*** coefficient is >2.5 times the standard error

associated with acceptance of an alternative production trajectory than with reduced-chemical production preferences within a "conventional" farming system. One possible explanation is that some of the less common breeds are better adapted to grazing than are Holsteins (Bowman, 1992; Shirley, 1993; Cramer, 1994).

The findings point out the diversity of farm production/management strategies within New York dairying and the importance of this diversity for agricultural sustainability. Policymakers, modelers, farmers, activists and others should take into account differences in farm and market structure when considering interventions to enhance environmental performance at the farm level.

Our sample is limited to one geographical area and one commodity. Therefore, caution should be used in extrapolating these results to other regions or other commodities. Our intent is to inform the process of policy development and to provide the sustainable agriculture movement with ideas and evidence to support strategies to improve agricultural sustainability.

Acknowledgments. We thank Max Pfeffer, Gilbert W. Gillespie, Gerry Walter, and an anonymous reviewer for helpful comments on earlier drafts. This research was supported by the Farming Alternatives Program of Cornell University and Cornell University Agricultural Experiment Station in conjunction with USDA regional research project NE-177.

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RESOURCES

"Grazing on Public Lands" is $20 from Council for Agricultural Science and Technology, 4420 West Lincoln Way, Ames, IA 50014-3347; (515) 292-2125 or 1-800-375-CAST.

"A Geography of Hope: America's Private Land," published by the USDA's Natural Resources Conservation Service, is available at no charge for single copies at 1-800-THE-SOIL.

"The Balanced Budget Amendment: Implications for Agriculture" is free from Environmental Working Group, 1718 Connecticut Ave., NW, #600, Washington, D.C. 20009; (202) 667-6982; on the World Wide Web at http://www.ewg.org.

Proceedings from "Building Local Partnerships: Water Quality, Watersheds and You," held in January, 1997, are $12.50 from Robin Pruisner, 2104 Agronomy Hall, Iowa State University, Ames, IA 50011-1010; (515) 294-6429.

"Successful Whole Farm Planning: Essential Elements Recommended by the Great Lakes Basin Farm Planning Network" is $6 from the Minnesota Project, 1885 University Ave. West, #315, St. Paul, MN 55104; (612) 645-6159; e-mail water007@gold.tc.umn.edu.

"Direct Marketing and Related Topics," citations from the AGRICOLA database, is available from Alternative Farming Systems Information Center, National Agricultural Library, USDA, 10301 Baltimore Ave., Room 304, Beltsville, MD 20705-2351; (301) 504-6559; e-mail afsic@nal.usda.gov.

"Growing Together: Community Gardening and Food Security" is free from Sustainable Food Center, 434 Bastrop Hwy., Austin, TX 78741; 1-800-882-5592.

"Beyond the Last Fencerow: The Future of the Food and Farm System in Southeast Pennsylvania" is free from Kathy Koehler, Regional Infrastructure for Sustaining Agriculture, (610) 683-1400.

"Composting Grass Seed Straw" is $1.50 from Publication Orders, Extension and Experiment Station Communications, OSU, 422 Kerr Administration Bldg., Corvallis, OR 97331.

Proceedings of the Fourth Annual Fertilizer Research and Education Program Conference are free from the Program, (916) 653-5340; e-mail ccady@smtp1.cdfa. ca.gov.

"Educational and Training Opportunities in Sustainable Agriculture" is available from Alternative Farming Systems Information Center, National Agricultural Library, Room 304, 10301 Baltimore Ave., Beltsville, MD 20705-2351; (301) 504-6559; e-mail afsic@nal.usda.gov.

"Municipal Density and Farmland Protection: An Exploratory Study of Central Valley Patterns" is $12 from Agricultural Issues Center, University of California, Davis, CA 95616; (916) 752-2320.

"Paying the Piper: Subsidies, Politics, and the Environment" is $5 plus $4 postage from Worldwatch Institute, 1776 Massachusetts Ave., NW, Washington, D.C. 20036; (202) 452-1999.

"The Cornerstones Model: Values-Based Planning and Management" is available from the Heifer Project International, P.O. Box 808, Little Rock, AR 72203; 1-800-422-0474.

"Cultivating a Better Future: Sustainable Agriculture in Montana" is $7 from Alternative Energy Resources Organization, 25 S. Ewing, #214, Helena, MT 59601; (406) 443-7272.

"Agriculture and the Environment: Building Local Partnerships," proceedings from a January, 1996, conference, are $17.50, payable to ISU, from Robin Pruisner, 2104 Agronomy Hall, Iowa State University, Ames, IA 50011; (515) 294-6429.

UPCOMING EVENTS

June 5-6, "Resource Use in Organic Farming" will be held in Ancona, Italy; contact Dr. Juan Isart, Coordinator ENOF Concerted Action, University of Ancona, Via Brecce Bianche, I-60131 Ancona, Italy; phone +39-(0)71-220-4929.

June 5-8, the joint meetings of the Agriculture, Food, and Human Values Society and the Association for the Study of Food and Society will be held in Madison, WI; call (608) 263-1672.

June 8-12 and June 15-19, "Grasslands 2000," International Grassland Congress '97, will be held in Winnipeg, Manitoba (June 8-12) and Saskatoon, Saskatchewan (June 15-19); sponsors include Gov. of Canada and Agri. Inst. of Canada; contact (403) 244-4487; e-mail amc@forage.org.

June 16-27 and July 14-25, Permaculture Design Courses will be held in Santa Barbara, CA (June 16-27) and Half Moon Bay (July 14-25); contact International Institute for Ecological Agriculture, 834 West California Way, Woodside, CA 94062; (415) 365-2993; e-mail DBLUME@igc.apc.org.

June 21-22, 1997 Pacific Northwest Bamboo Agro-forestry Workshop will be held in Port Townsend, WA; contact Gib Cooper, (541) 247-0835; e-mail bambugib@harborside.com.

June 25-28, 3rd International Interdisciplinary Conference on the Environment will be held in Cambridge, MA; contact Demetri Kantarelis, Assumption College, (508) 767-7557, or Kevin Hickey, (508) 767-7296.

July 22-25, Soil and Water Conservation Society Annual Conference will be held in Ontario, Canada; contact Jennifer Pemble, 1-800-THE-SOIL, ext. 18; e-mail jenp@swcs.org.

July 30-31, Leopold Center for Sustainable Agriculture's 10th Anniversary Conference will be held in Ames, IA; contact Rich Pirog, Leopold Center, 209 Curtiss Hall, Iowa State University, Ames, IA 50011; (515) 294-3711; e-mail rspirog@iastate.edu.

Farmers' commitment to continued use of the late spring soil nitrogen test

Cheryl K. Contant and Peter F. Korsching

Abstract. *Within the past decade, low cost and convenient soil tests have been developed and marketed to permit better matching of soil nitrogen levels with crop needs. We explore the factors related to farmers' initial adoption and their commitment to continued use of one such kit, marketed in Iowa as N-Trak. Early adopters of the N-Trak had many of the same personal and farm operation characteristics as farmers who have been early adopters of other farming innovations. Further, the principal factors in differentiating between various levels of commitment to continued use of the kit were perceptions of technological attributes of the kit and, to a much lesser extent, farmer attitudinal factors and personal characteristics. These results suggest that perceived attributes of the technology, especially its returns to time, effort, and financial investment, were critical in the decision to adopt and continue to use the N-Trak kit. Early adopters' decisions to continue using it focused primarily on cost, profitability, and technological issues, to the exclusion of water quality concerns measured by attitudinal items. These findings suggest that providing information that shows the kit's ease, compatibility, and advantages, would be more persuasive than marketing it as a tool to enhance water quality.*

Key words: technology, soil test, adoption-diffusion, sustainability

Introduction

To maintain high yields and protect against losses of soil nutrients, U.S. farmers traditionally have applied large amounts of nitrogen fertilizer on row crops such as corn. Over two-fifths of the fertilizer used in U.S. agriculture is applied to corn (U.S. Dept. of Agriculture, 1987). Whereas the total amount of N fertilizer has declined in the past decade, the application rate continues to rise or remain steady (National Research Council, 1989, 1993). The continuing high levels of N application have both economic implications for farmers and environmental implications for society.

With growing public interest in agricultural impacts on the environment, especially water quality, high rates of N applications have come under increasing scrutiny. Farmers themselves have begun to question the need for high fertilizer application rates, particularly with the introduction of new tests that permit matching soil N levels to the crop's needs. The ultimate success of the new, lower-input fertilizer management approaches will depend in part on the development and rapid adoption of low cost, easy to use, and convenient tests for amounts of soil-based N (National Research Council, 1993). For corn growers in Iowa, such a test recently became available: the N-Trak late spring soil test.

Developed by Iowa State University and marketed by the Hach Company under the trade name "N-Trak," the late spring soil N test is a valid and reliable instrument for Iowa soils (Blackmer et al., 1989). The test kit was first made available commercially to farmers in the 1990 crop season. The test is used about mid-June, when the corn is 0.15 to 0.30 m high, to determine the amount of N available in the soil for plant growth. In conducting the test, farmers prepare composite soil samples from several parts of their fields, dry them, and combine them with chemicals from the kit. The color of the soil solution is then matched with a color wheel to determine the amount of N available in the soil.

Through such site-specific evaluation of available N, farmers can reduce their preplant applications of N, determine the amount of additional N needed, and adjust the last spring supplemental side-dressing accordingly. The initial cost of the N-Trak kit is low ($125 in 1991), and the expense of using it is low compared with excessive fertilizer applications. It is small-scale, requires no specialized knowledge or equipment other than what is included in the kit, and is designed to be user friendly. These features would seem to encourage quick and widespread adoption; that is, it is valid, reliable, inexpensive, and easy to use. The kit also has the potential for enhancing agricultural sustainability by significantly reducing the amount of N fertilizer applied to corn, thus lowering input costs and improving the quality of ground and surface waters (Hallberg et al., 1991; Blackmer and Morris, 1992).

Farmers' Commitment to Using the Kit

In 1990, the year of the kit's introduction, a total of about 1,700 kits were sold, about 900 to Iowa farmers. In our survey of kit purchasers in Iowa conducted in July

Journal Paper No. J-14753 of the Iowa Agriculture and Home Economics Experiment Station, Ames, Iowa. Project No. 2717.

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1990, shortly after the farmers' initial use of the kit, 93% of the respondents (n=301) stated that they definitely or probably would use it again the following year. A follow-up survey of the same farmers was conducted in December 1990 to determine their perceptions of and reactions to the kit after harvesting their crops. At this point they could make an informed, comprehensive assessment of the kit from their experiences and perceived economic benefits.

Three groups were defined according to their commitment to continued use of the kit: those who were positive about it, those who were guardedly optimistic, and those who were negative. This paper explores the factors that are related to farmers' commitment to continued use of the N-Trak kit. We examine the following factors with potential for explaining farmers' commitment to the technology: farmers' perceptions of the attributes of the technology; their perceptions and attitudes about water quality and environmental issues; and their personal and social characteristics.

Commitment to continued use of a new technology or innovation such as the N-Trak kit could be considered as a decision to implement or adopt a technology, as described by the diffusion of innovations model. Early models of the decision-making process in the diffusion of innovations suggested that individuals will use innovations on a trial or limited scale if the innovation permits. A trial stage was explicitly included in these early models because research suggested that many farmers do go through a trial before adopting on a full-scale basis (Bohlen, 1964). A successful trial was followed by the final stage, adoption.

Rogers (1995) dropped the trial stage of the decision-making process in his revision of the diffusion of innovations model because not all potential adopters go through a trial stage. However, he stated that most individuals will try a new technology in the decision stage, and he includes trialability as a key attribute in the decision to adopt or implement the innovation. Furthermore, in Rogers' (1995) fifth stage, the confirmation stage, each continuing use of the innovation is a trial, in that the adoption decision is never final. The individual seeks continual reinforcement for the adoption decision; new results countering earlier successes at any time may lead to discontinued use. In both the original and the revised model, several factors contribute to the decision to adopt or reject the new technology.

Perceptions of technological attributes

Research has consistently shown that perceptions of an innovation's attributes are related to its rate of adoption. Rogers (1995) suggests five basic attributes that influence the adoption and continued use of new technologies: relative advantage, compatibility, complexity, trialability, and observability. Each of these attributes has several dimensions. Rogers (1995, pp. 250–251) provides a good review of research showing the relationship between these attributes and the adoption of new technologies. However, there is less research on how the adoption and continued use of environmentally beneficial farming technologies is related to these attributes. For each of the attributes above, we suggest additional dimensions and discuss previous research findings for other agricultural innovations.

For the N-Trak kit we suggest that three dimensions of relative advantage will be related to its adoption and continued use: financial advantage, time and labor requirements, and ease of use. Moon (1982) found these attributes to be positively related to the adoption of soil conservation practices among Iowa farmers. Since the kit is cheap, return on the investment comes in the immediate cropping cycle. Since it is easy to use, adoption and continued use should be enhanced. On the other hand, the kit requires considerable labor, which could discourage continued use.

Two dimensions of compatibility are relevant for adoption of the N-Trak kit: compatibility with existing farming practices, and a related but distinct dimension, compatibility in the timing of the kit's use with other farming activities. Moon (1982) also found compatibility to be associated with adoption of conservation practices. The N-Trak test must be conducted when the corn is from 0.15 to 0.30 m tall, normally mid-to-late-June, when many other activities compete for the farmer's time. Large areas of corn to be tested and the high labor requirement of the test exacerbate this concern.

Perceived complexity of the technology can affect adoption through the farmer's confidence in the ability to use the technology and confidence in the results. Carlson and Dillman (1988) found that among a group of farmers in the Washington/Idaho Palouse region, adoption of no-till farming was related to the farmers' mechanical skill, particularly the skill level needed for solving complex mechanical problems.

Trialability of an innovation is enhanced by the availability of information on its use. Nowak (1983) found that the most serious obstacle faced by many nonadopters of conservation tillage is the lack of accurate and useful information. In another instance, to promote no-till farming among producers in the Washington/Idaho Palouse region, situation-specific information was needed (Carlson and Dillman, 1988). For the N-Trak kit, Iowa State University Cooperative Extension Service, Practical Farmers of Iowa (a sustainable farming organization), and Hach Company (the distributor and marketer for the kit) all promoted it heavily with information on its specific application to corn.

Finally, observability of results affects adoption, with adoption enhanced when expectations of the technology are met. The N-Trak kit, on the other hand, can provide measurable results at the completion of the annual cropping cycle, i.e., enhanced or decreased profits, indicating the degree to which expectations were met. This situation is unlike most other agricultural innovations that prevent environmental contamination, for which results usually are seen only in the distant future with reductions in soil erosion, sedimentation, water pollution, and soil fertility (Nowak and Korsching, 1979).

Perceptions and attitudes toward the environment

Perceptions of the nature and severity of environmental problems are important for farmers' willingness to take remedial action. Although farmers consistently tend to underestimate the severity of environmental problems such as soil erosion (Hoover and Wiitala, 1980), farmers who are aware of problems, especially at the local or farm level, are more aggressive in taking corrective action (Korsching and Nowak, 1983; Bultena and Hoiberg, 1986). Therefore, we expect farmers with a greater awareness of local water quality problems to have a

greater commitment to continued use of the N-Trak kit. Furthermore, positive attitudes toward preserving environmental quality are related to the use of environmentally benign or enhancing farming practices (Petrzelka, 1991) and should be positively related to continued use of the N-Trak kit.

Personal and social characteristics

There is a consistent relationship between farmers' age and the adoption of environmentally beneficial conservation practices, with younger farmers more likely to adopt such practices. Coughenour and Chamala (1989) found younger farmers in Kentucky more likely to adopt conservation practices, and Bultena and Hoiberg (1983) and Korsching et al. (1983) found the same relationship for conservation tillage in several other states. Although it is unclear why younger farmers tend to adopt conservation practices more readily, a possible explanation is that younger farmers are more aware of environmental issues or are more willing to take action to ameliorate environmental problems because they have a longer anticipated future in using resources.

Research also shows that higher education is related to use of conservation practices. Farmers with higher education are more likely to use no-till (Carlson and Dillman, 1986), leave recommended amounts of crop residue on conservation-tilled fields (Nowak and Korsching, 1985), and have a farm conservation plan (Coughenour and Chamala, 1989). A higher level of education seems to indicate greater management capability (Nowak and Korsching, 1983).

Previous research provides little guidance on two remaining characteristics. Off-farm employment shows the need to supplement limited farm income. This could increase the likelihood of continued commitment to N-Trak as a way to reduce expenses; alternatively, the kit's labor requirement may limit continued use, particularly if use conflicts with the time demands of off-farm employment. The use of microcomputers also should be related to continuing commitment to N-Trak. Innovators in one area, such as computers, also tend to be innovators in other areas (Rogers, 1995).

Methods

Data collection

We conducted two surveys to examine the relationship of these technological, attitudinal, personal, and social factors to farmers' commitment to continued use of the N-Trak kit. The first survey, conducted in late July 1990 (just after kit usage), included attitudes toward farming and water quality issues, reactions to the kit usage, personal and family characteristics, and off-farm employment. This survey was mailed to a systematic random sample of 600 Iowa farm operators who purchased the N-Trak kit in 1990. Names and addresses of kit purchasers were provided by the Hach Company. A total of 301 valid, complete surveys were returned (50% response). There appeared to be no pattern in the nonresponses, so this response rate was regarded as adequate (Babbie, 1995).

At the end of that year, we sent a follow-up survey to the 301 respondents to the initial survey. Topics on this survey included a post-harvest assessment of the kit and its effects on farm management. Of the 301 questionnaires sent out, 259 were completed and returned (86% repeat response rate).

Analytical approach

We conducted two analyses of the data collected from these two surveys. The first concerned the qualities and characteristics of the first adopters of the N-Trak kit in Iowa and their general assessment of their experiences with the kit. Several personal and farm characteristics are presented below and contrasted with statewide statistics for Iowa farmers. In addition, we present descriptive summaries of responses to other survey questions to characterize farmers' initial hopes and expectations for the kit.

The second analysis was used to aid in understanding farmers' commitment to continued use of this new technology. We used discriminant analysis to determine which of the technological, attitudinal, and personal characteristics discussed above were significant in differentiating farmers' commitment toward continued use of the kit. Discriminant analysis is a strong statistical tool that can be applied to a set of independent variables to determine how well they distinguish between several groups of a dependent variable (Norusis, 1990).

In our analysis, the independent variables included the various technological, attitudinal, and personal factors described below. The dependent variable, commitment to continued use of the kit, is whether the farmer "would use the kit again next crop year." Responses were obtained shortly after harvest, when experiences and sentiments toward the kit could be accurately and reliably recalled. *Positive* assessment for continued use resulted from a "definitely" response; *guardedly optimistic* assessments resulted from a "probably" response; and *negative* assessments were associated with "no" or "only with major changes" responses. Of the total responses (n=136) used in subsequent analyses (i.e., those without missing values for relevant variables), 48% of the respondents were positive, 42% were guardedly optimistic, and 10% were negative toward continued use of the kit.

Variables used in the analysis

Definitions for each of the independent variables used in the discriminant analysis are presented below. Some variables are indexes created from an individual's responses to several questions contained in the surveys. In other cases, an individual's response to a particular survey question or series of questions provides the value for a newly defined independent variable.

Perception of technological variables. Most of the technological variables are defined by individual responses to a particular survey question. In each question, the farmer was asked to assess the impact of the kit on farm management, finances, and decision making. A seven-point Likert scale (with the endpoints defined for each question) is used to determine the value for the first eight independent technological variables.

For the attribute relative advantage, three variables are defined: "What are the *financial costs* of using the N-Trak soil test on your farm?" (1 = costs exceed returns; 7 = returns exceed costs); "What are the *time and labor costs* required to do soil testing with the N-Trak kit?" (1 = time and labor costs are high and unacceptable; 7 = time and labor costs are low and acceptable); "How *difficult or easy is it to use* the N-Trak

soil test?" (1 = very easy; 7 = very difficult).

Two dimensions of compatibility were measured: "How compatible is the N-Trak soil test with *your existing farming* practices and equipment?" (1 = not compatible; 7 = completely compatible); "How compatible is the *timing* of the N-Trak soil test with other activities on your farm?" (1 = not compatible, to 7 = completely compatible).

The dimension of complexity was measured by two factors: "How confident are you with *your ability to use* the N-Trak soil test kit?" (1 = very confident; 7 = not at all confident); "How confident are you with the *results/recommendations* of the N-Trak soil test?" (1 = very confident; 7 = not at all confident).

Another technological attribute, trialability, includes an assessment of the availability of information on the innovation: "How *easy or difficult is it to obtain information* or assistance for using the N-Trak soil test?" (1 = very easy; 7 = very difficult).

The final attribute included as a technological factor characterizes the observability of results. We measured this variable by determining whether a farmer's expectations about the soil test kit were met (that is, observed). Responses to the question "When you used the N-Trak kit, were your expectations met?" were either yes (1) or no (0).

Perceptions and attitudes toward the environment. We measured four attributes of a farmer's perceptions and attitudes toward agricultural operations and the environment. First, we asked farmers which factors among a series of economic, environmental, and other considerations were their reasons for purchasing the N-Trak kit. Farmers were asked to provide weights to each of six possible responses by assigning a percentage value to each response; the values had to add to 100. We then added the percentage values for the two factors describing environmental considerations: "Reduce the amount of chemicals infiltrating into ground and surface waters" and "Because I'm worried about what farm chemicals are doing to the environment." The larger the value, the greater the concern for the environment.

A second variable was created to characterize a farmer's assessment of agriculture's contribution to water quality problems in a series of progressively closer geographical areas. The larger the value for this variable, the more the farmer perceives the water quality problem to be from agricultural sources and the nearer it is to the farmer's own operation. We divided possible sources of contamination into agriculturally related (runoff of pesticides and fertilizers, sediments from soil erosion, or infiltration of agricultural chemicals into groundwater) and nonagricultural sources (wastes from factories and industry, sewage from towns and cities, or others). The locations of water quality problems were the state, the county, and their own farms, with assigned values of 1, 2, and 3, respectively. In computing the variable, if a farmer perceived agricultural sources to be the greatest contributors to water quality problems in the state (1), in the county (2), and on the respondent's farm (3), this variable receives a value of 6. If agricultural sources were viewed to account for water quality problems only at the county level, a value of 2 was assigned. If nonagricultural sources were believed to contribute to water pollution at any of the locations, a value of 0 was assigned for that location.

The final two variables in this group of attributes were produced from a factor analysis of nine attitudinal statements scored on a five-point Likert scale. Each question asked the respondent's level of agreement/disagreement with a particular statement. Two factors emerged from the analysis. Each was defined along with the statements included in the variable. Some statements were recoded to adjust for reverse scoring of positive and negative statements (shown by "R").

The first factor describes farmers' concern over their water resources and consists of responses to the following statements: "I worry about the quality of my drinking water" (R); "Even if there are no known human health threats, water resources should be protected for plant and animal life" (R); "I believe my drinking water is contaminated" (R).

The second factor captures farmers' assessment of the value and safety of agricultural chemicals in their farming operations: "I am confident that agricultural pesticides, if used as directed, are not a threat to the environment"; "We already have too much regulation on the use of agricultural pesticides"; "For me, the savings made in more precise fertilizer and pesticide applications are not worth the added time and effort"; "Agricultural chemicals are the best alternative to control crop weeds, pests and plant diseases"; "A good cropping system should include rotations of small grains or forage along with row crops" (R); "I would like to use some means other than chemicals to protect crops from weeds, insects and disease" (R).

Personal and social characteristics. Four characteristics were used in this study to capture personal or social factors that might influence farmers' commitment to continued use of the N soil test. Respondents were asked their age in years as of their last birthday, and how many years of school they had completed. Farmers also were asked whether they had used a personal computer in their farm operations, with yes coded as 1 and no coded as 0.

The final social characteristic in this study is off-farm employment by the principal farm operator in the past year. No off-farm employment received a value of 1, working part-time off-farm received a 2, and working full-time off-farm received a 3.

Results

Table 1 summarizes several farm operations and personal characteristics of early adopters of the N-trak kit and of farmers throughout Iowa in 1990. Compared with farmers statewide, the early adopters operate larger farms with a correspondingly higher gross farm income. The split between owned and rented land is slightly different, with early adopters renting a greater fraction of their land than farmers statewide. Yield goals and average corn yields in the previous year and the previous three years are similar between the two groups. Early adopters on average are several years younger than farmers statewide, and have slightly more schooling.

These findings are quite consistent with previous studies that found that early adopters of other conservation farming practices tend to be younger and better educated (Bultena and Hoiberg, 1983; Carlson and Dillman, 1986; Coughenour and Chamala, 1989). Interestingly, although on average the early adopters operated larger farms and had higher farm incomes, their corn yields were almost the same as for farmers statewide.

Table 2 shows the early adopters' most frequently identified expectations of the kit

Table 1. Characteristics of N-Trak adopters and farmers statewide.

	N-Trak Adopters	Statewide 1990[1]
Farm Characteristics (average)		
Size (ha)	273	183
Owned	129	81
Rented	150	96
Corn planted (ha)	134	89
Corn yield (kg/ha)		
1987–89	7220	7660
1989	7470	7410[2]
1990 Goal	8980	8790
Operator Characteristics (average)		
Age (years)	42	55
Years of school completed	14	13
Gross farm income (% of respondents)		
<$20,000	4	7
$20,000–59,999	20	29
$60,000–99,999	18	24
$100,000–250,000	39	29
>$250,000	19	11

[1] Information extracted from Contant et al. (1995).
[2] Skow and Holden (1990).

Table 2. Expectations in using N-Trak kit (n=301).

Expectation of Kit Use	% of Respondents Indicating Reason
Determine N needs accurately	60.8
Lower N costs	32.3
Easy and accurate alternative test	12.2
Reduce environmental effects	7.3
Curious about new technology	2.9

(multiple responses were possible, so percentages add to more than 100). The greatest expectation was the kit's ability to determine N needs more accurately than previous methods. Other expectations included lowering N costs and finding easy and accurate test alternatives to existing soil tests. Reducing environmental effects was mentioned by less than 10% of the respondents.

We next used discriminant analysis to determine which technological, attitudinal, and personal characteristics were significant in differentiating between the various levels of farmers' commitment to continued use of the kit. Table 3 contains the univariate analysis of variance results from the discriminant analysis for the nine technological, four attitudinal, and four personal and social characteristics included in the analysis. These results show which variables are sufficiently different among farmers with the three levels of commitment to help discriminate between these groups. A variable was retained in later discriminant analyses if it differed significantly ($p<0.05$) among the three groups.

Eight of the nine technological variables are significant in this initial discriminant analysis. All three dimensions of relative advantage (financial advantage, time and labor requirements, and ease of use) and the two compatibility dimensions (compatibility with present practices and timing compatibility) are significant. Observability and the two dimensions of complexity (confidence in ability to use the kit, and confidence in results) are also significant. Only the variable describing trialability, that is, the availability of information on the kit, has little power in distinguishing between the groups.

Of the four attitudinal variables, only two—reasons for purchasing the kit and concerns over water resources—are significant. The two factors, location/type of water pollution problems and the value of agricultural chemicals, are not significant.

Four personal characteristics are examined in this initial discriminant analysis. Age, level of education, and off-farm employment do not discriminate between groups. The only personal factor that is significant in the analysis is previous use of personal computers.

Of the three general categories of variables examined in this analysis, many more technological factors (eight out of nine) are significant in discriminating between groups. Personal and attitudinal factors play a much smaller role (one out of four and two out of four, respectively).

Variables identified as significant in Table 3 were then included in a discriminant analysis. The discriminant findings presented in Table 4 show that the 11 independent variables that are significant at $p<0.05$ correctly classify 68% of the cases into the correct groups for commitment toward continued use of the kit. Strength of association was assessed by squaring the canonical correlation. Approximately 40.8% of the variance in commitment to continued use of the kit was explained with this discriminant analysis. The related Wilks' Lambda value was 0.547 with an F value of 3.93 ($p<0.0001$).

Besides these measures of the strength of the overall discriminant analysis, it is important to examine the magnitude and direction of the effect of each set of independent variables in the final discriminant function. First, most of the perceived technological factors were significant in the final discriminant function and the effect was in a positive direction. For example, compared to the guarded and negative groups, the positive farmers described the kit as offering a greater financial advantage (mean of 6.03 compared with 4.79 and 4.15 for guarded and negative groups, respectively), greater ease of use (4.71 compared with 4.14 and 3.38), greater timing compatibility (4.53 compared with 3.56 and 3.23), higher levels of expectations met (0.848 compared with 0.526 and 0.077), and higher confidence in kit results (5.23 compared with 4.67 and 4.00). Other technological variables, including time and labor requirements, compatibility with existing practices, and confidence in ability to use the kit, also influence commitment, but less strongly.

Results for perceptions and attitudes toward the environment were mixed. The

Table 3. Initial univariate results in discriminating between levels of commitment to continued use of N-Trak kit.

Potential Discriminating Factor	F Value	Signif.
Perception of Technological Attributes		
Relative advantage		
Financial	10.75	.0001[1]
Time and labor requirements	14.28	.0001[1]
Ease of use	6.81	.0017[1]
Compatibility		
Compatible with existing practices	12.22	.0001[1]
Timing compatible	5.53	.0053[1]
Observability - expectations met	15.97	.0001[1]
Complexity		
Confidence in ability to use kit	3.19	.0455[1]
Confidence in kit results	8.75	.0003[1]
Trialability - availability of information	0.29	.7492
Perception and Attitudes toward the Environment		
Location/type of water pollution problems	1.30	.2764
Reason for purchasing kit	3.45	.0357[1]
Concern over water resources	4.18	.0182[1]
Value of agricultural chemicals	1.10	.3376
Personal and Social Characteristics		
Age	0.22	.8009
Education	0.52	.5946
Off-farm employment	1.15	.3207
Previous use of computers	3.35	.0393[1]

[1] Included in later analysis ($P<0.05$)

signs of these two coefficients were opposite one another, but neither factor possessed a strong influence in the discriminant function.

Results for the one significant personal characteristic, previous use of personal computers, were unexpected. On average, more farmers who were negative toward continued use of the kit used personal computers (0.605) than did the positive (0.348) or guardedly optimistic farmers (0.509). This negative relationship could be due, in part, to the level of technological sophistication involved in the two innovations: the kit is "low tech," whereas computers are perceived to be more technologically sophisticated. Also, the size, specialization, and complexity of the farm operation might create this apparently inconsistent response to different types of innovations. Farmers with larger and more specialized operations requiring many complex tasks may be less committed to a labor-intensive innovation such as N-Trak, compared with a time-saving innovation such as personal computers.

Discussion and Conclusions

The discriminant analyses and the comparison of N-Trak kit purchasers to a statewide sample of farmers provide interesting insights into the characteristics of early adopters and their commitment to future use of the kit. These results have significant implications for design and marketing of technologies, such as N-Trak, intended to enhance agricultural sustainability.

Early adopters of the kit had personal and farm operation characteristics similar to farmers reported in the literature as early adopters of other farming innovations. They tended to be younger and better educated and to operate larger farms than Iowa producers in general.

Most adopters bought the kit because of its potential benefits for crop productivity and profitability (real, immediate, and observable outcomes). They were less interested in its benefits for water quality or environmental protection through recommendations for reduced N usage. These findings suggest that farmers had a short-range, highly tangible motivation for kit usage: reduced costs and higher profits.

The discriminant analysis substantiates these findings. The principal factors differentiating among levels of commitment to continued use of the kit were technological considerations and, to a much lesser extent, attitudinal factors and personal characteristics. Five of the six variables discriminating most strongly among levels of commitment were technological. Perceived attributes of the technology, especially its observability, its return on financial investment, and its timing compatibility, were critical in the decision to continue to use the N-Trak kit. Other factors relating to attitudes and values were considerably less important for understanding a farmer's commitment to continued use of the innovation. One personal characteristic, previous use of personal computers, was a strong negative influence. This finding suggests that farmers may not view all innovations equally. For example, those farmers with interests in higher level technologies (i.e., personal computers or other computer-driven technologies) may have found the "low tech" nature of the N-Trak kit frustrating or imprecise, leading to less commitment to future use.

These findings reinforce the importance of the trial use of an innovation. Although we do not have comparable data on the farmers' perceptions of the N-Trak kit before using, it is reasonable to assume that their assessment of its perceived attributes was based on their experiences and results using it. Those farmers who rated the kit lower on its relative advantages, its compatibility with other aspects of the farming operations, the observability of results through met expectations, and the complexity of using the kit presumably also had more difficulty using the kit or did not achieve satisfactory results.

An unsuccessful trial may have resulted from any of several reasons: the nature of the farming operation; the farmer's ability and knowledge; the weather; or the complexity, appropriateness, soundness of design, and reliability of the technology itself. Some factors, like the weather and the technology's reliability, are beyond the farmer's immediate control during implementation in the field.

Other factors, such as the farmer's knowledge and ability, can be enhanced and the technology's complexity can be reduced with

Table 4. Discriminant analysis findings for significant predictive variables.

Independent Variable	Mean of *positive* group (n=66)	Mean of *guarded* group (n=57)	Mean of *negative* group (n=13)	Standardized discriminant function coefficient
Perception of Technological Factors				
Relative advantage				
Financial	6.03	4.79	4.15	0.385
Time and labor requirements	4.85	3.84	2.69	0.088
Ease of use	4.71	4.14	3.38	0.229
Compatibility				
With existing practices	5.68	4.71	3.76	0.164
Timing compatible	4.53	3.56	3.23	0.311
Observability - expectations met	0.848	0.526	0.077	0.601
Complexity				
Confidence in use of kit	5.54	5.33	4.69	–0.107
Confidence in kit results	5.23	4.67	4.00	0.219
Perceptions and Attitudes toward the Environment				
Reason for purchasing kit	22.12	16.45	26.15	–0.043
Concern over water resources	21.41	19.21	20.46	0.134
Personal and Social Characteristics				
Previous use of computers	0.348	0.509	0.615	–0.243
Summary Statistics				
Canonical correlation coefficient	0.639			
Wilks' Lambda	0.547	(F=3.93)		
Significance Level	0.0001			
Percent correctly classified	67.6			

information on how to use the kit. How-to information reduces the user's risk and uncertainty, two potential stumbling blocks that accompany the implementation of any new technology. However, the availability of information and assistance did not significantly affect commitment to future use. Apparently, respondents' perceptions about information needed to use the kit did not vary across the groups or was perceived to be adequate. If the perceptions of adequate information are valid, that is, if additional information would not have helped to achieve better results, then the perceptions of the other technological attributes are critical in determining commitment to continued use.

This does not bode well for the adoption of new, environmentally benign, more sustainable technologies among farmers. For the N-Trak kit's promoters, farmers' interest in protecting the environment through decreased N application was considered as important for adopting the kit as reducing production costs. But as the results indicate, early adopters' decisions to continue or discontinue using the kit focused on cost, profitability, and technological issues, not water quality concerns.

Farmers' attitudes toward water quality may have played an important role in the initial decision to purchase the kit, but do not seem to have a significant influence on its continued use. The predominance of technological factors in determining continued use of the kit suggests that providing information that shows its technological ease, compatibility, and advantages would be more persuasive than packaging it in response to certain attitudinal or personal motivations to enhance agricultural sustainability or environmental protection.

For example, demonstrating that the kit can control water quality problems is not likely to be as powerful a motivator for its continued use as showing that it is compatible with a farmer's present equipment and practices. That does not mean that the farmer is not interested in the kit's benefit to water quality; it simply does not appear as strong a motivating factor in farmers' decisions about continued adoption of this new technology. Therefore, to enhance continued adoption of the kit, information promoting it should concentrate on its technological advantages.

A detailed analysis of the early adopters of a new technology can yield insights into factors that motivated the innovators to adopt the technology initially and factors that will affect its continued use. Our findings suggest that those individuals or organizations involved in marketing or teaching about new technologies should examine in detail the motives that led innovators to adopt the technologies. Further, they should re-examine those factors to determine in what ways they are leading to differing levels of commitment to continued use of a new technology. This should help ensure that the most appropriate and influential information about and support for the technology is being provided to these early innovators.

Acknowledgments. We thank Cathy Young, formerly of the University of Iowa's Public Policy Center, who worked extensively on the data collection and coding, and the following research

assistants in the University of Iowa's Graduate Program in Urban and Regional Planning, who assisted us: Michelle Javornik, Brien Schumacher, Jay Chakraborty, and Kala Sridhar. Completion of this paper was made possible by a research assignment for Cheryl Contant (provided through the University of Iowa's faculty development programs) at the University of Minnesota's Humphrey Institute of Public Affairs. We also thank several reviewers for their helpful comments on the manuscript, the Hach Company for assistance throughout the project, and the many farmers who spent valuable time in completing our surveys. This research was sponsored by the Leopold Center for Sustainable Agriculture, Iowa State University; the Public Policy Center, University of Iowa; and The Iowa Agriculture and Home Economics Experiment Station, Iowa State University.

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President's 1998 Budget Maintains Sustainable Ag Funding

The USDA budget submitted by President Clinton for Fiscal Year 1998, which begins in October, maintains funding for most sustainable agriculture programs. It includes a request to double the funding for the Organic Foods Production Act, and an increase of $13 million for integrated pest management. An $8 million appropriation is requested for the Sustainable Agriculture Research and Education program, the same as the FY97 appropriation. A $3.3 million appropriation is requested for the SARE (Chapter 3) Professional Development Program, the same as the FY97 appropriation.

Local food systems and sustainable communities

Gail W. Feenstra

Abstract. *The long-term health of a community's food system is an important indicator of its vitality and sustainability. A logical and appropriate way to revitalize a community is by the development of a local food economy. People throughout the United States are designing and implementing sustainable, local food systems that are rooted in particular places, aim to be economically viable for farmers and consumers, use ecologically sound production and distribution practices, and enhance social equity and democracy for all members of the community. This paper reviews the existing literature on local food systems, examines a variety of strategies and initiatives that are currently underway, and identifies steps that community leaders and citizens can use to develop their own local food systems. Finally, I suggest what research is needed to support these community efforts.*

Key words: community economic development, foodshed, food policy councils, regional food guides, food self-reliance, direct marketing, community food security

Introduction

The long-term health of a community's food system is an important indicator of its vitality and sustainability. Not only does an adequate, varied diet contribute to individual health, but the *way* food is grown, distributed and eaten also profoundly affects the environmental, social, spiritual and economic well-being of the community. In many places, a logical and appropriate way to revitalize a community is by the development of a local food economy. People throughout the United States are designing and implementing sustainable, local food systems tailored to their community's needs. This does not mean they completely isolate themselves from trade, but that they adapt local food production and markets based on local environmental and community health priorities. These local food systems are rooted in particular places, aim to be economically viable for farmers and consumers, use ecologically sound production and distribution practices, and enhance social equity and democracy for all members of the community.

This paper reviews the existing literature on local food systems, examines a variety of strategies and initiatives that are currently underway, and identifies steps that community leaders and citizens can take to develop their own local food systems. Finally, I suggest what research is needed to support these community efforts.

The Historical Context

Ecological, cultural and political analyses over the last two decades hold in common the vision of a more local, ecologically sustainable, and democratically controlled food system. A seminal work that directly related individuals' dietary habits to the earth's resources and the food economy was Lappe's *Diet for a Small Planet* (1975). Lappe made a convincing case that greater food security for all people could be achieved if we ate lower on the food chain. *Food First* (Lappe and Collins, 1978) further articulated the economic and political realities of the global food system and how they are used to perpetuate the myth of scarcity and the continuation of hunger in communities worldwide. Lappe and Collins encouraged communities to take control of their own food economies. Hightower (1973, 1976) discussed issues of corporate control in American agriculture and its effect on farmers, farmworkers, consumers, and the quality of the food system. Berry's *The Unsettling of America* (1977) powerfully and poetically described the loss of community and culture that accompany the uncritical acceptance of agribusiness and mechanization in our food and agricultural system. Gussow (1978) edited a thoughtful collection of essays, *The Feeding Web*, that tied together concerns about food, nutrition, culture, and the environment. More recently, Kneen (1993) reviewed the ecological and social costs of the global food system and described a vision of more localized, sustainable food systems built on justice and community.

Others (Getz, 1991; Hendrickson, 1993; Kloppenburg et al., 1996) describe the potential for developing alternative, more local food systems through the concept of a "foodshed." According to Getz, a foodshed is the area that is defined by a structure of supply. A local foodshed not only describes a geographic area and the foods that can be grown within it, but also the social and cultural elements of a community. Investigating all these elements is essential to understanding the unique aspects of the food system in a community. The local knowledge that is gained through such observations allows us, as Crouch (1993) notes, to become native to our place, our community.

By 1980, the Cornucopia Project (1981) of Rodale Press began a systematic study of the nation's food system. It documented the fundamental problems with the food system on a national level in *The Empty Breadbasket?* (1981), and commissioned studies of the food systems of several states, including New York (Messing, 1981), Pennsylvania (Hollander, 1983), California (Pahl, 1983), Maine, Ohio, and Minnesota. These studies

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examined how much and which foods of the state's food supply were imported and exported, and considered the ecological, social and political implications. Recommendations were made for consumers, farmers, state and local governments, the food industry and the research community to regenerate and localize their state's food and agricultural economy. These studies and the Cornucopia Project outreach began to make people more aware of their food and agricultural systems and what they could do to make them more sustainable.

Since the Cornucopia projects, several local initiatives and studies have been conducted throughout the United States to examine the sustainability of food and agricultural systems and the feasibility of creating more local food economies. These can be divided into five categories: regional food system studies; manuals or models for community data gathering; educational strategies; food policy councils; and existing community food system projects. I examine prominent examples from each category to discover what insights they provide and what questions they raise.

Regional Food System Studies

The studies reviewed in this section analyze the potential for various states, regions, counties or cities to realize a more localized food supply. They provide valuable insights into the kinds of information that are helpful in developing a local food economy. These studies focus on: conducting historical reviews of agricultural production in the region to determine what foods can be produced; estimating the region's present self-reliance in food; identifying local, i.e. seasonal, foods and developing guides to them; conducting local marketing studies of producers and consumers; understanding urban agriculture and the connection with hunger; and establishing local food policy or planning councils.

Local, sustainable agriculture and seasonal diets

Some studies (Haughton, 1982; Gussow and Clancy, 1986; Herrin and Gussow, 1989; Hamm, 1993a) link local, sustainable agriculture with seasonal diets. Several studies include reviews of the history of agricultural production in the local area. They identify a rich variety of local crops and livestock that were once produced and eaten by residents. They also identify reasons for the decline in local production of these foods. Sometimes the loss of local food processing capabilities is the key factor influencing the crops that are grown and eaten.

Other studies collected quantitative data to estimate the extent of the state's present or previous self-reliance in food. Hamm (1993a) used a nutrient based approach, comparing the total nutrient production of the state with the total nutrient requirement of the people of New Jersey. Herrin and Gussow (1989) calculated production and consumption data for a variety of foods to determine the extent of Montana's food self-reliance. The most reliable studies use statewide food production and marketing data, along with extrapolations from national consumption surveys. The results reveal that food self-reliance has declined over time, but that residents *could* get more of their nutrients from local sources, especially if they changed their diets to reflect seasonally available foods.

Researchers then began to identify foods available locally, in season. Herrin and Gussow (1989) created nutritionally adequate menus using locally available foods for each season of the year. Hamm (1993a) and Herrin and Gussow (1989) also promoted the development of regional, seasonal food guides. Regional food guides now exist for British Columbia, Canada (British Columbia Ministry of Health, 1994), for Placer County, California (PlacerGROWN, 1995), and for the northeastern United States (Wilkins and Bokaer-Smith, 1996). Gussow and Clancy (1986) discuss a similar guide for a sustainable diet by analyzing the Dietary Guidelines from an ecological perspective and suggesting options for more sustainable dietary choices. All these studies intentionally link the products of local agriculture with a new type of dietary guidance based on seasonal foods instead of on food groups alone.

Marketing and consumer studies

Another important dimension of the local food economy is the marketing potential for local sustainable foods. Studies conducted by Arthur D. Little (1985), the Minnesota Project (1986), Yellow Wood Associates (1988), the Association for Agricultural Self-Reliance (Campbell and Pearman, 1994), Fricker Group and Sunflower Strategies (1994), and a project conducted by the Midwest Organic Alliance (1995) focus on developing local agricultural markets for growers in their regions. Four others conducted by Lockeretz (1986), Bruhn et al. (1992), Thomson and Kelvin (1994), and Nayga et al. (1995) examined consumer demand for locally grown foods. In these studies, researchers and community groups used surveys, focus groups and interviews to examine the supply and demand for local foods.

These marketing studies suggest that a cooperative marketing strategy with technical assistance and an emphasis on local markets may be helpful in expanding the local food economy. The studies find three key components of successful marketing strategies. First is the establishment of a regional identity based on high quality products. This includes using logos, promotional materials and celebratory events, to build support from consumers and the local processing industry.

Second is the need for cooperative marketing strategies and technical assistance to initiate cooperative efforts. The New York State study (Arthur D. Little, 1985) suggests creating a center for cooperative market development funded by the state and producers. The New York regional study (Yellow Wood Associates, 1988), the Renfrew County study (Campbell and Pearman, 1994) and the Humboldt County study (Fricker Group and Sunflower Strategies, 1994) suggest forming grower cooperatives. These cooperatives might share grading, packing and storage of regional produce. They also might exchange equipment, initiate a revolving loan fund, or coordinate workshops on low-input production techniques and on marketing and processing of local products. Another cooperative strategy suggested by the New York and Minnesota regional studies is to compile a detailed listing of buyers, commodities and farmers (a market link service) so that buyers and producers could make contacts and expand local markets. The Midwest Organic Alliance is currently strengthening regional organic growers' infrastructure through business support services and by linking farmers with processors.

The third key element mentioned by all studies is the importance of quality among buyers (both wholesale and retail) and processors. Product quality is also crucial in the consumer demand studies. These studies find that consumers would buy more locally grown products if they are of high quality, the price is competitive and they are in a "local-oriented" environment (such as a farmers' market).

Urban food system studies

The final studies in this section, by Ashman et al. (1993), the Sustainable Food Center (1995), and Joseph (1996), focus on connecting low-income city residents and local agriculture as a way to improve community food security. The studies in Los Angeles, California (Ashman et al., 1993) and in Austin, Texas (Sustainable Food Center, 1995) begin by documenting the extent of hunger and the structure of the existing food systems in their communities. They suggest improving transportation systems and encouraging more supermarkets in the inner city, and include creative solutions for putting residents directly in touch with local foods. Joseph (1996) outlines local solutions to improve food security for Massachusetts residents. Strategies include producing local food through community gardens or urban farms, encouraging residents (especially participants in the Women, Infants and Children program) to buy directly from local farmers at farmers' markets and produce stands, and encouraging government food programs to buy local foods.

All three studies recommend establishing food policy councils to coordinate the disparate elements of the city's food system and develop links between consumers and local farmers. (Food policy councils will be discussed in more detail later.) The urban focus is an important element in regional food systems studies because it intentionally expands the concept of a local food system to the poor. As will be discussed later, this is both an opportunity and a challenge.

Manuals for Data Gathering

Various food system manuals are available to help citizens ask specific questions about their food systems and gather data to guide their decisions. Two manuals, *Organizing a Local Cornucopia Project: A Manual for Changing Your Food System* (Cornucopia Project, 1982) and *The Food and Agriculture Workbook* (Cantrell, 1991) are particularly suited to help community participants systematically examine their present food system and discover its potential to become more locally based and sustainable. They might best be used together since their strengths and weaknesses complement each other's.

Both manuals include a section on community process—organizing community meetings, formulating the agenda, determining goals, and choosing specific activities. *The Food and Agriculture Workbook*, especially geared for smaller communities, is much more complete in this regard. The workbook is organized into a four-step community process, in which groups use worksheets to collect information, analyze the state of the local food and agricultural system, and identify options to revitalize their local food economy. Projects are chosen according to local knowledge and an understanding of the community's unique food and agricultural characteristics and opportunities. *A Manual for Changing Your Food System*, on the other hand, describes many more concrete ideas and specific activities, from individual activities such as composting to community ventures such as organizing a land trust. A companion manual called *Strategies for a Sustainable Food System* (Cornucopia Project, undated) lists additional activities, programs and policies.

The Hartford Food System is preparing *A Guide to the Development of Community Food Systems* (Mark Winne, Director, Hartford Food System, private communication, June 1996). The *Guide* will provide practical information on developing community food systems and assist in creating a national network of community food system practitioners. Its emphasis is on linking regional agriculture and urban food needs, food policy planning initiatives, urban food retailing, and sustainable food production.

Educational Strategies

This section includes four very different educational strategies that focus on regional food systems in the northeastern United States (Maretzki and Anderson, 1991; Nettleton, 1996), in the Pacific Northwest (Nuxalk Food and Nutrition Program, 1984) and in the Midwest (Land, Food, and Justice Committee, 1986). All four projects involve a collaboration of stakeholders in the food system, with leadership coming from different sectors: Cooperative Extension, community health clinics and the religious community. These are three potentially powerful allies in developing local food systems.

The Northeast Network for Food, Agriculture and Health Education (Maretzki and Anderson, 1991) involves Cooperative Extension, citizens and community leaders in developing a policy education program for the northeastern food system. Participants facilitate discussions and activities about how food safety, food costs and nutrition are related to agriculture, health, food processing, distribution, and marketing. The work is designed to help citizens examine the consequences of alternative food policies and make informed decisions. This project provides a model for involving Cooperative Extension and taking advantage of resources at land-grant universities to raise awareness about food system issues.

The other project in the Northeast (Nettleton, 1996) involves Cooperative Extension and several nonprofit collaborators in the New Farmers New Markets program. This program rebuilds and expands existing farmers' markets while developing new, viable markets in underserved neighborhoods. The program works with community-based organizations to educate neighborhood youth and new immigrants in market-oriented sustainable food production. Besides their educational benefits, these efforts contribute to community-based economic development and regional employment.

The Nuxalk Food and Nutrition Handbook (1984) resulted from a collaboration of the Nuxalk native people of British Columbia with nutrition and community health professionals to promote the use of native foods and understand the benefits for personal health, the household and community economies, and native cultural and spiritual life. The program was run out of the health clinic and included regular meetings with elders about the history of the food system, nutrition classes emphasizing traditional foods, food gathering demonstrations, periodic traditional feasts, and a Nuxalk food garden. The project successfully reintroduced traditional, regional foods through the health sector. Local

health clinics are often part of the network for reaching low-income and ethnic groups. Because of their economic situation and many of the food traditions they retain, people in ethnic communities may be the most receptive to becoming involved with regional food systems.

The last project in this section, *There is a Season: Cooking with Good Things Growing in Michigan* (1986), is one example of many cookbooks that emphasize regional, seasonal recipes (Tudge, 1980; St. Paul Farmers' Market, 1985). This was a project of the Land, Food, and Justice Committee of the Interfaith Council for Peace, a group that includes people from the sustainable development, anti-hunger, and religious communities. Besides providing recipes using fresh, local foods, the cookbook directs consumers to farmers' markets and discusses food preservation techniques so that local foods may be eaten year-round. These practical tools help individuals translate their values into concrete actions. Members of religious communities and others interested in environmental justice are likely allies in educating the broader public about local food systems (DeBoer and Schlabach, 1981; Granberg-Michaelson, 1984; Presbyterian Eco-Justice Task Force, 1989; Jubilee Agriculture Ministries, 1994).

Food Policy Councils

Over the last decade, more cities, counties and regions have recognized the important role local governments can play in addressing food security and its relation to local, sustainable agriculture. Food security has been defined as the state in which all persons always obtain a nutritionally adequate, culturally acceptable diet through local, nonemergency sources (Ashman et al., 1993). However, community food security means more than simply ensuring access to food for all individuals. It has also come to represent a community-based, prevention-oriented framework that includes empowerment of community members, economic development strategies and more direct relationships between producers and consumers (Gottlieb and Fisher, 1996). To ensure a more coordinated approach to community food security, nutrition, health and agricultural issues, some cities have established various forms of food policy councils (FPCs) (Minneapolis Food Policy Task Force, 1987; Dahlberg, 1994; Toronto Food Policy Council, 1992, 1995). These cities recognize that food is an important component of a healthy, sustainable community and that the food system has major impacts on employment, waste management, transportation, and the health and well-being of the larger ecosystem.

Dahlberg (1994) and Clancy (1994) analyzed the successes and failure of food policy councils nationwide and developed important insights about how these institutions contribute to the stability of regional food systems. Dahlberg's study of five cities and one county found that a strong, supportive mayor, good links with staff in local governments and competent FPC organizers all influenced the degree of formal institutionalization an FPC could achieve. The more effective FPCs were more institutionalized, with a budget, staff, and planning powers. He also found that FPCs with a very strong emphasis on hunger issues were less likely to be successful in the long-run. In contrast, the successful FPCs tended to give significant attention to broad reforms aimed at making urban systems more sustainable and equitable.

Clancy (1994) offered additional insights from the demise of the Onondaga County, New York, Food Policy Council. Barriers to success included: conservative views of farmers; the crisis-orientation of farmer participants; research and extension efforts at the land-grant university directed at helping farmers get bigger; apathetic consumers; and a lack of credibility. She made several suggestions: carefully choosing the region in which to put efforts; encouraging the involvement of Cooperative Extension in food systems issues; encouraging the development of new local markets; encouraging more community-supported agriculture (CSA); and searching for supportive, innovative farmers.

Recent food security planning efforts have been coordinated nationally by the Community Food Security Coalition, formed in the summer of 1994. The Coalition drafted the Community Food Security Empowerment Act (1995) and successfully influenced the passage of the Community Food Security Act as part of the Nutrition Title of the 1995 Farm Bill. This act will provide $16 million for the next seven years (FY 1996 - FY 2002) to community-based projects designed to meet the food needs of low-income people, increase the food self-reliance of communities, and promote comprehensive responses to local food, farm and nutrition issues.

Existing Community Food Systems

There are hundreds of creative projects that link individual community members, institutions and businesses directly with local farmers to improve local food economies. They include more than 1,750 farmers' markets (Lyson et al., 1995) and 550 community-supported agriculture projects nationwide (Robyn Van En, founder of CSA of North America, private communication, June 1996), and hundreds of community and school gardens, urban farms, and other community demonstration projects. This section will review a small sample of those projects that are innovative in their approaches, that attempt to employ a comprehensive strategy to localize their food economies, and that have been documented. They represent communities that range in scale from a small college campus to a large western county. Each uses the concept of local food systems to educate community members about local agriculture, address urban hunger, improve community economic vitality, and involve residents in community relationships around food.

Several colleges have researched their local food systems and implemented plans to purchase locally and sustainably produced foods. From 1986 to 1991, Hendrix College students, in cooperation with the Meadowcreek Project in Arkansas, generated thousands of dollars in the local economy by increasing in-county food purchases from 1% to 15% of total food purchases and in-state food purchases from 6% to 30% (Yazman, 1991). Other benefits included closer ties to the community, more nutritious foods, and a cooperative warehouse that now serves Hendrix College and other local institutions. The honesty with which the obstacles are documented and addressed and the slow, steady way in which the Hendrix College project phased in changes make this study a particularly useful model. Carleton and St. Olaf Colleges in Minnesota did a similar study (Aegerter et al., 1990), making recommendations that, if adopted, could boost local food purchases

from 19% to 39% of the college food budget.

Other community demonstrations have made creative urban-rural linkages between local agriculture and urban communities. Drumlin Farm's Food Project (Massachusetts Audubon Society, undated) brings together city and suburban youth to grow food for Boston area soup kitchens, homeless shelters, and farmers' markets that serve low-income neighborhoods. A project in New Brunswick, New Jersey, provides fresh, organic produce harvested from a small-scale, intensive vegetable farm at Cook College, Rutgers University to the community food bank, soup kitchens, local restaurants, a roadside stand and a CSA project (Hamm, 1993b). The Homeless Garden Project in Santa Cruz, California (1992) employs homeless people to produce fresh produce for a CSA and a farmers' market. The Stockton Food Bank in California grows food for its clientele and for a CSA on a 5-acre urban farm (Bruce Giudici, Stockton Food Bank, private communication, February 1996). Low-income people receive scholarships to participate as shareholders. Inner-city youths work on the farm and are trained in small business skills.

One of the oldest, most successful, and most comprehensive community projects that builds community-food relationships is the Hartford Food System in Connecticut. Its mission is to develop a long-term equitable and sustainable food system that can address the underlying causes of hunger and poor nutrition. Its programs have included food production, agricultural marketing, local food retailing, nutrition education/information and community economic development (Hartford Food System, 1993, 1994). In the last 15 years, the Hartford Food System has instituted a variety of innovative programs that directly link low-income urban residents with local farmers. Examples include: "Farm to Family," in which more than 50,000 Connecticut seniors and WIC participants receive farmers' market coupons, "Community Farmstands" that sell Connecticut produce in neighborhoods with limited access to fresh fruits and vegetables, a "Delivery Service" for homebound seniors, and "Food Stamp Outreach" at farmers' markets and roadside produce stands. In 1994, the Hartford Food System began a CSA project at Holcomb Farm in nearby Granby, Connecticut. Half the shares are sold to local suburban residents; the other half go to Hartford community groups that serve low-income residents. The Hartford Food System also has been active in lobbying for improvements in federal food programs, influencing the use of land for community gardens, participating in Hartford hunger studies, and establishing the Hartford Food Policy Commission in 1991. These programs have benefitted Hartford residents not only economically and nutritionally, but also socially and culturally.

The University of California Sustainable Agriculture Research and Education Program has funded two unique community food systems projects. First is the Arcata Farm and Education Project (Lehman, 1994). Located on a 4-acre parcel leased from the city of Arcata, the project is a student-run educational working farm with a CSA component. Students from Humboldt State University and local elementary schools learn about sustainable agriculture and marketing through direct farming experiences, labs, and on-site classes. The community is involved through their participation in the CSA, several harvest and planting celebrations, and workshops on organic gardening, composting, Integrated Pest Management (IPM), sustainable farm management, and edible landscaping. The Arcata Farm directly involves the low-income Hmong population by sharing some of its land for the families to raise gardens and keep chickens. Farm staff members and students share resources with the Hmong families, who can grow some of their food sustainably and improve their nutritional and economic well-being. The Farm has involved local farmers and Cooperative Extension by sponsoring a conference in spring 1995 on sustainable production, marketing, land use issues, and community economic development. The variety of community outreach ideas has contributed to making the Arcata Farm a visible and valuable community project that links many people with their local food system.

The second project is a countywide, cooperative agricultural marketing program in Placer County called PlacerGROWN (Junge et al., 1995). Originally funded by a grant from the Placer County Board of Supervisors, PlacerGROWN was designed and is now implemented by a diverse planning group including Cooperative Extension, farmers, ranchers, consumers, farmers' market managers, and representatives from local government. The project includes a nonprofit membership organization that promotes local Placer products within and outside the county, a research component with producer and consumer surveys to determine the need for expanding local markets, and the development of a local food guide called "A Reason for the Season." Consumer education about eating local seasonal foods is being conducted through Cooperative Extension Master Food Preservers and other trained volunteers. Restaurants, retail food stores, and farmers' markets are included in outreach. Workshops and conferences about sustainable production and direct marketing have been important in reaching local growers and ranchers. PlacerGROWN also conducts an annual tour of PlacerGROWN participants for interested consumers, other farmers, policymakers, local agricultural resource agencies, and the media. Connections with the community are widespread and are contributing to the success of PlacerGROWN.

Community Strategies and Research Needs on Local Food Systems

What can we learn from the diverse projects just described? The suggestions presented here describe some activities and research questions for communities interested in making their local food and agricultural systems more self-reliant. Each community, however, must decide for itself what will or will not work, depending on its particular capabilities.

Learning about the local food system

One of the first requirements of engaging in this work is to understand more about one's own regional food system. The following kinds of information will be most helpful.

Historical reviews of agricultural production in the region. This information helps identify the potential for creating more agricultural diversity. A historical review might also reveal the reasons that production and consumption trends have changed over time and can point to ways for

reintroducing local processing and value-added activities. The study of Montana's and New York's food systems (Haughton, 1982; Herrin and Gussow, 1989) and the Humboldt marketing study (Fricker Group and Sunflower Strategies, 1994) included historical reviews and trends in production and consumption, although with differing degrees of detail. The Montana study's list of previous and current locally grown foods was used by Montana Cooperative Extension agents as a supporting document for local farmers attempting to secure bank loans for vegetable production. The Humboldt study was used to create a marketing strategy for fresh and processed local foods in Humboldt County, California.

Estimates of the region's present self-reliance in food. Obtaining as much actual information about which foods are produced, consumed, exported and imported helps communities get a picture of the region's food economy and how it might change. The Cornucopia studies, the Montana study and the New Jersey study (Hamm, 1993a) all used quantitative analyses to make these estimates. Gathering reliable data is difficult and time-consuming, often requiring assumptions that may compromise the accuracy of the estimates. It is much easier to collect statewide (vs. regional) data because government reports usually exist on crops, pesticide use, water, production, consumption, poverty indicators, etc. Some of these data are available at the county or city level, but regional and bioregional data are much harder to obtain. In some studies, it was necessary to extrapolate state level estimates from national data because the national data were more consistent. Similarly, county or multicounty data could be extrapolated from statewide data. However, researchers sometimes conducted their own surveys to get a more accurate picture. Before engaging in data collection, it is important for community members to be clear about the purpose of their efforts. This will help guide them in deciding how detailed their analysis needs to be and whether they can use existing data or will need to collect their own.

Conducting historical reviews and studies of a region's food self-reliance is an ideal research activity for colleges and universities. Even better are studies that combine the resources of research institutions with those of the community. The Placer-GROWN project has used resources from Cooperative Extension and the County Board of Supervisors to conduct local food production and consumption studies in Placer County. More studies that ask questions about regional food self-reliance are needed. Data are particularly lacking on the economic and social benefits that local food systems offer to communities. A first step will be to identify meaningful indicators and measurement methods. These studies not only will provide helpful information to communities, but will also validate this area of research within the academic community.

Identification of local, seasonal foods and development of food guides. A food guide can be a helpful tool for educating consumers, institutional food buyers, educators, policymakers and area farmers about the potential for eating more local foods. Research is needed on whether the food guides currently in use (British Columbia Ministry of Health, 1994; Placer-GROWN, 1995; Wilkins and Bokaer-Smith, 1996) are effective in changing consumers' knowledge, attitudes and eating habits. Although food guides are an important educational strategy, by themselves they do not significantly influence local production to meet local demands.

Marketing studies. These can be helpful in understanding food distribution dynamics, barriers, and opportunities within a specific region. They put the people who conduct them in closer touch with the reality of a particular food system, its participants, the control points, and the possible changes. They also provide reliable information about the needs of producers and buyers. The New York and Humboldt, Minnesota, marketing studies all provided very specific information about local producers and consumers and how they might be linked within their regions. Research is needed that examines the food distribution sector in other regions, analyzes barriers to local marketing, and suggests areas where opportunities might exist.

Urban agriculture. For regional food systems that encompass large urban areas, the Los Angeles and Austin food systems assessments are useful models (Ashman et al., 1993; Sustainable Food Center, 1995). These studies describe current defects and suggest alternatives for improving food security. Community or individual gardens can be a significant source of local food for urban and rural residents. Direct marketing, including U-pick and roadside operations, farmers' markets, and CSAs, are successful methods for expanding local agricultural markets. Although direct marketing represents only a small fraction of total agricultural receipts, it still is an important source of income for area farmers and can provide substantial amounts of quality food to community residents.

On the other hand, marketing in low-income neighborhoods offers a major challenge to small, family farmers. Food cost is the primary barrier. Innovative solutions have been found by programs such as the Hartford Food System, which encourages the Farmers' Market Nutrition Program and food stamp use at farmers' markets and roadside stands. Others, such as the farm at Cook College (Hamm, 1993b), use a CSA to subsidize food production for low-income people at the community food bank or soup kitchen. Here, shareholders' prices help pay the labor to harvest extra food for the food bank and soup kitchen. The Stockton Food Bank provides scholarships for low-income people to participate as shareholders in its CSA. More research and collaboration with community residents is necessary to identify barriers and find new strategies that will benefit both farmers and residents of low-income communities.

Choosing a process for gathering community food system data and strategizing

To gather information in an organized way, groups need to be clear about their goals, particularly the importance of a community economic development component in their vision of a regional food system. The manuals described earlier are available to help communities in this process. A trained facilitator often is needed to assist a strategic planning effort, particularly where groups are large or represent diverse perspectives.

Using multiple community resources for outreach and education

Besides the agricultural organizations and agencies, other excellent resources for analyzing the food system and educating

the community include institutions of higher education, the nutrition community, the health sector, and churches and synagogues. Each has its own networks and outreach potential. The creation of community food system dialogues in the Northeast Network and on a smaller scale in the Nuxalk project is one model for involving community members in food system issues. Research is needed to assess how effectively such dialogues change people's behaviors to support a more local, sustainable food system. Other educational strategies that involve consumers in food growing, processing food, purchasing food directly through farmers' markets or CSAs or cooking seasonally encourage more active participation in the food system. Research is needed to identify which educational strategies are most effective and under what conditions.

Involving the religious community in food system studies and projects builds on existing and probably untapped relationships in community food systems work. Religious organizations already commonly provide space for and sometimes staff soup kitchens, food pantries and food drives, so they have substantial knowledge of hunger and other community food system problems. Because they share common values, the formation of networks among religious, environmental, food/hunger and sustainable agricultural groups is a promising strategy.

Local food policy planning

Food policy development and planning is a critical element that links production and distribution aspects of a local food economy. Besides helping to coordinate the ways that community residents get access to quality food, a food policy also can create new linkages with area farmers, particularly those committed to sustainable production. It also can develop policies that protect prime farmland, preserve topsoil, and encourage entry-level farmers, local processors, or food-related businesses. Finally, a food policy within a local government makes the idea of a regional food system a more tangible reality for citizens and invites democratic participation.

The development of trusting relationships is critical to the success of a food policy council, especially among the mayor, local government staff, and FPC organizers. In more rural settings, trust must be built in the farming community so that growers also "own" the process. This can be done by working with Cooperative Extension or establishing direct marketing relationships such as CSAs. Both a key success factor and a common pitfall is to build diversity into the FPC. The community must be broadly defined so that both urban and rural participants will invest in their food system. As new food policy councils are initiated, research such as Dahlberg's (1994) will be needed to evaluate strengths, weaknesses, and opportunities for new food policy planning models. Research also is needed that links food policy with land use and agricultural policy and incorporates each into city or regional planning.

Creating harmonious urban-rural linkages

The best local food systems are characterized by a broad vision of the food economy that addresses both urban and rural concerns. These concerns, from food access to farmland preservation to community health, are seen as everyone's. The creation of regional food systems links people from urban neighborhoods with people from local farms to make one community. This community provides adequate food to residents, a sustainable farming system, a safe, clean environment, and satisfying social and cultural interactions around food.

There are three key elements to realizing this vision. The first is leadership. In each project reviewed here, identifiable leaders have built strategic relationships throughout the community. What sets them apart is their ability to build trusting relationships with diverse participants, from food service workers to farmers. This, in turn, increases the pool of volunteers committed to the work. These leaders combine a broad understanding of community food systems and a process orientation. This allows them to use resources creatively and effectively, obtaining both individual and collective investments from farmers, consumers, retailers, and others. The result is a wealth of creative ideas for community outreach and involvement.

The second key to successful projects is collaboration, reflected in diverse representation on the boards, advisory committees, and planning groups. Participant involvement also is diverse, especially in projects that include low-income people and different ethnic groups. Recently, local groups have begun linking in national networks such as the Community Food Security Coalition.

Finally, building a successful regional food system depends on fostering the politics of civic renewal. McKnight (1995, p. 61) describes this politics as "interactive—the debate of citizens regarding purpose, value, and power . . . citizens pooling their intelligence to achieve maximum human good . . . the art of the possible—a process that recognizes limits and grapples with the questions of equity imposed by those limits." In projects like the Hartford Food System and the Arcata Farm, the real meaning of community politics is being restored as citizens—farmers, urban residents, hunger advocates, policymakers, and others—struggle together to restore regional food security, enhance economic vitality, and develop the democratic capacity of local citizens. In this way, the growing network of local food systems projects is making its mark on the renewal of American public life.

Acknowledgments. I thank David Campbell, Director of the UC California Communities Program, for his excellent comments on several drafts of this paper. Thanks also to Nancy Wilkins for her help in contacting many organizations described here. Molly Anderson, Jennifer Wilkins, and Rod MacRae provided invaluable feedback. I also thank Joan Gussow for her comments on an early draft and for her constant encouragement in continuing this work. The California Alliance for Sustainable Agriculture (CASA) provided partial funding for this paper.

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Avery's Recommendations "Fall Short," Say Professors

The policy recommendations made by Dennis Avery in an article in *Choices* magazine "fall short of resolving serious global poverty and environmental problems," according to two professors who responded to Avery's article. Both the Avery article and the response by Fred Fitzhusen and Craig Davis of Ohio State University appeared in the First Quarter, 1997, issue of the peer-reviewed magazine of the American Agricultural Economics Association. Asserting that "the biggest danger to the world's natural environment today is low-yield agriculture," Avery advocated the adoption of "advanced farming methods" and concluded that "the only food strategies likely to protect the world's remaining wildlife are further advances in sustainable crop and livestock yields, and radically liberalized trade in farm products." He also criticized the Wallace Institute's publication, *Intensive Agriculture and Environmental Quality: Examining the Newest Agricultural Myth,* as making "tiny and poorly-founded criticisms."

In their response to Avery's article, Fitzhusen and Davis wrote that "Avery's future scenario is particularly dependent on major increases in per capita income among the world's poor; significant increases in environmentally benign, yield-increasing technologies for food and fiber production on prime agricultural lands; and a global free trade regime. . . . Avery exposes his lack of understanding of biodiversity and its causes, confusing the conservation of wildlife and wild lands with the more general and critical concerns of conserving overall biodiversity. . . . The construction of social policy on the basis of selective use of what we understand about the causes of biological diversity is poor science and makes for poor policy." Their main criticisms "are that he understates the potential downstream environmental impacts of agricultural intensification, overlooks the extreme difficulty of fostering and targeting economic development to reduce extensive poverty in much of the developing world, and grossly oversimplifies the complexity of the underlying causation of species distribution and abundance."

Community-controlled economic development as a strategic vision for the sustainable agriculture movement

Dave Campbell

Abstract. *The threat to sustainability posed by global economic integration and the surging interest in local and regional food systems provide an opportunity to unite the diverse constituencies of the sustainable agriculture movement behind a common political and economic agenda. Neither the campaign to influence the Farm Bill nor a romantic vision of bygone agrarian communities are sufficient to broaden the movement's existing political base and deepen its influence. This paper suggests an alternative approach: grassroots organizing guided by the vision of "community-controlled economic development." Theory linking this new paradigm in local economic development to sustainable agriculture is presented, along with practical examples from innovative networks promoted by the California Alliance for Sustainable Agriculture (CASA). I analyze the experience of CASA organizations, both separately and as an alliance, to illuminate how a strategic vision of community-controlled economic development can enable the movement to meet three difficult political challenges: holding power accountable; unifying environmental and social agendas; and developing strong leadership accountable to the movement's community base.*

Key words: social capital, local food systems, grower information networks, marketing coalitions, farmland protection, farmworkers, community organizing

As global integration of the food and agricultural economy proceeds, so do efforts to develop local food systems attuned to the particularities of place (Ritchie, 1993; Feenstra, 1997). These countertrends will coexist, uneasily. The resulting political and economic tension provides a unique opportunity for the diverse constituencies of the sustainable agriculture movement to unite behind a common agenda. This agenda must do more than oppose the threats to sustainability posed by globalization. It also must articulate a strategic vision as compelling to the movement's community-based organizations as the notions of "free trade" and "comparative advantage" are to global corporations and their allies.

Important as they are, neither the campaign to influence the Farm Bill nor a romantic vision of bygone agrarian communities are sufficient to broaden the movement's existing political base and deepen its influence. I suggest an alternative approach: grassroots organizing guided by the vision of "community-controlled economic development." A strategy that links sustainable agriculture to community-controlled economic development is consistent with the movement's widely shared goal of promoting food and agricultural systems that are environmentally sound, economically viable, and socially just. It breaks with current movement thinking, however, in three ways: rather than considering sustainable agriculture primarily as a set of new production technologies, it defines it as an effort to assert democratic control over key power relationships in the food and agriculture system; rather than focusing most political energy on interest group bargaining over the Farm Bill, it promotes community organizing and the mobilization of social capital; rather than emphasizing the development of agrarian-based rural communities, it seeks to foster partnerships that bridge the urban-rural interface.

This paper provides a rationale for this alternative strategy. The first section notes the compatibility between the characteristics of sustainable agriculture and emerging theories in the field of local economic development. The second section relates this body of theory to the current practices of movement organizations, using as an example the innovative networks being promoted under the banner of the California Alliance for Sustainable Agriculture (CASA). CASA, of which I am a steering committee member, is a coalition of six nonprofit and three university-based programs funded by the W.K. Kellogg Foundation's Integrated Farming Systems initiative. CASA organizations are creating models of community-based education that help farmers, farmworkers, processors, educators, policymakers and others create communities that are prosperous, just, and democratic.

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Sustainable Agriculture, Social Capital and Community Economic Development

Spurred by practical necessity and informed by the vision of sustainability, a new approach to local economic development has emerged gradually over the past ten to twenty years. Older approaches dependent on industrial recruitment, government grants, or unsustainable resource extraction have proven increasingly unreliable because of global economic restructuring, prolonged fiscal stress in government, and environmental crisis (Bruyn and Meehan, 1987; Blakely, 1989; Fosler, 1991; Gunn and Gunn, 1991). Replacing them is a new emphasis on homegrown, community-based approaches that acknowledge natural constraints, develop existing assets, plug economic leaks, capture added value, and support local businesses (Ayres et al., 1990; Thomas, 1990; Kinsley, 1992; Fossum, 1993). As Schramm (1987) notes, these emerging strategies do not ignore the power of external market forces and private corporations, but try to change the way the local economy relates to those forces. The goal is a local economy that is vital, equitable, and secure, providing challenging work and empowering all community members.

As Strange (1990) has shown, many production and marketing practices associated with sustainable agriculture are consistent with these tenets of community-controlled economic development. For example, farmers substitute skilled labor and management for purchased inputs. Diversification of crops and livestock aids soil health but also lowers economic risks to farmers and farm communities. Direct marketing and on-farm or local processing add value and reduce economic leakage from the community. Conservation of natural capital creates economic value by maintaining the productivity of land and water resources while reducing "externalities," such as groundwater pollution or pesticide-related illness, whose costs are born by the public. Strange (1990, p. 6) concludes that:

> sustainable agriculture has local economic development benefits if it provides fuller employment of and increased return to farm resources; reduces economic "leakage" and generates increased demand for locally produced goods and services; produces increased demand for retail sales due to the multiplier effect of the previous two items; and reduces the costs which farming operations externalize to the local economy.

While farmers can act alone to achieve many of these results, all these strategies are enhanced when they collaborate with other farmers or community organizations. For example, import substitution can be speeded as farmers cooperate to devise pest control strategies specific to local conditions. Regional marketing promotions or other activities to add value can only be undertaken cooperatively, since they require levels of capital, technology, product expertise, or training that individual farmers lack.

The need for collaboration has become more evident as the sustainable agriculture movement's agenda has embraced the goal of community food security (Community Food Security Coalition, 1995). High poverty rates, hunger, and inadequate nutrition are prompting efforts to improve access to fresh, affordable, and nutritious foods, particularly among low-income families in rural and inner-city areas. This difficult work highlights the need for new coalitions that bring together rural and urban interests, such as anti-hunger organizations and farm advocates.

Such a collaborative politics must counter the strong individualist ethic in American political culture and draw instead upon the less prominent but equally persistent ethic of sharing and mutual sacrifice. Often known for their isolation and competitiveness, American farmers also have provided models of social cooperation such as barn raising and cooperative development. Such cooperation makes it more likely for local economies to be healthy. Summarizing his two decades of experience working on local economic development in both the U.S. and Canada, Perry (1987, p. 40) writes:

> For practical purposes, economic development is not the promotion of increases in gross national product or median family income or average per capita income or savings rates and investment capital or any of the usual indicators that people are accustomed to think of when they consider this idea. Instead, economic development is the creating and strengthening of new and available social tools in a community.

Perry's observation is supported by research on the role of "social capital" in fostering economic development and political democracy (Coleman, 1990). Putnam (1993, p. 167) defines social capital as "features of social organization, such as trust, norms and networks, that can improve the efficiency of society by facilitating coordinated actions." It was just this trust and cooperation that made farming communities of the past function, as farm tools and labor were borrowed reciprocally, allowing each farmer to get by with less physical or financial capital.

But Putnam does not relegate the influence of social capital to either the past or a utopian future. His research on Italy's complex, modern society concludes that the major determinant of whether a region will have a prosperous economy and healthy democracy is the presence or absence of "networks of civic engagement":

> Although we are accustomed to thinking of the state and market as alternative mechanisms for solving social problems, this history suggests that *both* states *and* markets operate more efficiently in civic settings. . . . Social capital, as embodied in horizontal networks of civic engagement, bolsters the performance of the polity and the economy. . . . Strong society, strong economy; strong society, strong state (Putnam, 1993, pp. 176, 181).

Flora (1995, p. 2) has connected the social capital thesis with sustainable agriculture. She finds that Midwest communities with concentrated populations of farmers practicing sustainable agriculture experience an upsurge in civic activity that elevates political debate and boosts local economic development:

> A pattern of problem solving guided by norms of mutual trust and reciprocity is encouraged by the sustainable agriculture movement and the various organizations that give social expression to that movement, and this is what helps to nurture and build social capital within small, agriculturally dependent rural communities.

Strange (1988) makes the same point negatively, observing that cutthroat competition and the absence of neighborly cooperation undermines the pursuit of cooperative policy goals and economic outcomes.

This literature suggests that the sustainable agriculture movement might foster internal unity and create strategic allies by recasting its existing activities under the banner of community-controlled economic development. The key is articulating how each of the movement's diverse constituencies are part of a broader effort to reassert community control over the production and distribution of food and fiber. This not only

aligns sustainable agriculture with those promoting sustainable community development in other fields, such as energy and health care, but also with the much broader array of political forces seeking decentralization, local control, community partnerships and home rule as alternatives to centralized bureaucracy.

Achieving the goal of community-controlled economic development will require deliberate and patient efforts to foster social capital within our communities and among movement organizations. As Schramm (1987, pp. 152–153) puts it: "For community-based economic development to succeed, linkages among democratic organizations must be strengthened at all levels of the economy, across sectors and geographic areas, to provide increased support for local efforts and a political and economic base for confronting the power of established private and public institutions."

Networks Linking Sustainable Agriculture and Community Development in California

Are these ideas relevant to the practical work of sustainable agriculture organizations? Does "community-controlled economic development" provide an umbrella broad enough to cover the wide diversity of movement activities? Can this approach deepen our social analysis and make our politics more effective? If "community control" is the goal, who is the community and how do we foster community cooperation among people schooled primarily in individualistic pursuits?

I consider these questions by examining the recent experience of the California Alliance for Sustainable Agriculture. For the past three years, CASA's member organizations have promoted community development in successful production and marketing projects. In addition, the nine-member CASA steering committee has struggled, with less success, to create joint projects that enhance or support the work of individual organizations.

"Community" has been defined by CASA in three distinct ways: by geographic region, by commodity, and by constituency. The specific agendas of each community association have varied, the primary forms being grower information networks, marketing coalitions, agricultural planning and policy coalitions, and a farm worker support center. The following summaries describe the achievements of these community networks, their degree of success in generating social capital, and their role in promoting more self-reliant community economies. In the discussion that follows I analyze how this experience can inform three challenges facing the sustainable agriculture movement as it seeks to increase its political influence: the need to hold concentrated power accountable, to unify environmental and social agendas, and to foster strong leadership accountable to the movement's community base.

Grower Information Networks

For many California crops, farmers have developed sustainable production practices, but documentation and dissemination of these innovations proceed slowly. Cutbacks in university funding and institutional resistance to change hamper the role of Cooperative Extension in serving this purpose. Pesticide-use reports, now mandated for all fields, reveal that pesticide use remains high and that most farmland still is under traditional chemical regimes. Often, farmers adopt these regimes on the advice of pest control advisors (PCAs) who are sales agents for chemical companies. The personal relationship of farmers with these PCAs, along with strict standards mandated by processors, are major influences on farmer decision making.

Grower information networks are an effective way to counter these institutional barriers. An example is the Integrated Pest Management (IPM) program of the Lodi-Woodbridge Winegrape Commission (LWWC), established in 1991 as a self-help, self-taxing marketing association. LWWC represents over 650 grower members whose production encompasses 50,000 acres of premium wine grapes, nearly 20% of California's total wine grape production. The Commission operates as a self-financed extension and pest control association, working with growers to promote sustainable production strategies that reduce conventional pesticide inputs and maintain the farmer's net income. This frees LWWC to leverage university or corporate resources without becoming a captive of their agendas.

The Commission promotes new management-intensive production regimes that add value by substituting skilled labor for purchased inputs. Initial leadership came from a small but influential group of farmers, including the owner of the largest farm in the district. These leaders saw that by making the transition to more sustainable methods they could head off regulatory burdens and build a positive, "clean" image for their crops and their community. In 1991 a core group of approximately a dozen cooperators began to hold meetings twice a year to spread information about the new practices. At that time, attendance at the meetings averaged about 50.

Five years later, LWWC boasts 120 cooperating farmers, and attendance at the biannual meetings averages 200 to 250. In addition, all farmers in the district receive multiple notices about monthly events such as field days or breakfast meetings, and a newsletter is circulated, so that the LWWC message is delivered frequently. Along with the strength and commitment of the initial leadership, the repeated exposure to the IPM message has been important for the organization's success. Equally important are the personal relationships between commission staff and farmers, since personality clashes or a perception that a staff member is not knowledgeable can slow progress significantly.

LWWC finds that combining personal connections and impersonal authority is much more effective than either by itself. For example, they have sponsored neighborhood meetings in which a dozen or so growers meet in a farmer's living room to share information. The friendly atmosphere in this setting has been highly successful in engaging new farmers. However, it builds on LWWC's earlier work to get the message out. Farmers who have read about the LWWC's efforts in trade magazines or other media are more open to making changes than if they had only a neighbor's word to go on. A big boost came recently when the Department of Pesticide Regulation (a division of the California Environmental Protection Agency) selected LWWC for California's first "IPM Innovators" award.

Another grower information network is a demonstration program initiated by the Community Alliance with Family Farmers (CAFF) to promote the adoption of locally proven, biologically based farming systems. Dubbed "BIOS: Biologically

Integrated Orchard Systems," the program provides participating orchard growers with modest financial incentives and with a management team that gives technical advice geared to their particular farms. The team consists of a unique collaboration: farmers who have pioneered innovative systems of sustainable production, a pest control advisor, a Cooperative Extension farm advisor, a researcher from the University of California Sustainable Agriculture Research and Education Program, and CAFF staff. The team conducts on-site visits, on-farm monitoring, monthly field days, and skills workshops, and is available for phone consultations and trouble shooting. Participating farmers expand their management options, become more familiar with neighboring farmers, and decrease their dependence on traditional pest control advice.

The program's successful work with groups of 20 to 30 almond and walnut growers in four counties sparked California state legislation (AB 3383) in 1994 to fund projects that apply the BIOS approach to other perennial crops. The legislation marked a rare occasion in which environmentalists, regulators, mainstream and alternative farming organizations, and university administrators rallied behind the same progressive farming legislation. Collaboration enables each group to solve problems they could not solve in isolation: administrators of the Department of Pesticide Regulation see their regulatory burden lifted by offering incentives to growers rather than penalties; growers receive financial and technical help during the difficult period of transition; environmentalists get pesticide reduction without appearing hostile to farmers; and the University answers critics who want it to alter its research agenda to address problems of immediate interest to farmers. The adversarial relations and political stalemate typical in regulatory policy making are replaced by collaboration involving government, industry, University, and public interest representatives. By the fall 1996, approximately 110 orchard growers will be participating in the BIOS program, a rapid expansion over the past two years. A new challenge facing the program is how to rotate new individuals onto the management teams to prevent staff burnout and to develop new leadership.

As important as "innovation" is for BIOS, so is continuity. Teamwork and new social relationships can facilitate adoption of sustainable agricultural practices, but also critical was the slower work that took place on a few innovative farms before the program was launched. A key feature of that work was the involvement of Cooperative Extension advisors who were trusted in the community and could speak in favor of the program at the initial meetings held to attract farmer participants. Having a familiar and trusted source of information made farmers more open to the innovative features of the program.

The Bio-Integral Resource Center (BIRC) has taken a different approach in promoting biologically based IPM practices among processing tomato growers in Yolo and Solano Counties. Over a three-year period they have enlisted 18 grower cooperators who have committed a combined 2,400 acres to IPM regimes. Potentially, up to 20,000 acres could be affected if these 18 growers made a complete transition on all their land. Unlike the Lodi case, BIRC started without a key group of farmer leaders to support the effort. They offer "Reference Field Monitoring," a grant-funded service that provides farmers with detailed, field-specific empirical information on which to base pest control decisions. To broaden the project's impact, weekly data summaries are distributed to all processing tomato growers in the region (approximately 250).

The payoff comes when farmers see that the fields managed with IPM practices can be just as productive as similar fields nearby where heavy amounts of chemicals were sprayed. As this occurs, BIRC researchers build trust with farmers and find greater receptivity from university and extension representatives, industry officials and others. This gives them a fragile but growing legitimacy as they seek to transform the grower/PCA relationship to one in which both scientific credibility and personal interaction are vital. Instead of the traditional system, where growers rely on pest control recommendations from PCAs employed by pesticide companies, BIRC focuses on educating growers themselves to make the final pest control decisions based on quantified field data collected by independent PCAs or appropriately trained farm employees.

Efforts to build a sense of community among these Yolo and Solano County growers have proven more difficult than in Lodi. In part this is due to the highly competitive nature of the processing tomato industry, where the financial risks and rewards associated with a given year's crop are very high. Also, these tomato growers are less unified either by being close geographically or by a commitment to preserving a "small farm lifestyle." Still another barrier is the role played by tomato processors, who set extremely low pest tolerance levels, rejecting entire shipments if any tomatoes are damaged.

Each of these information networks recasts growers: instead of passive recipients of expert advice, they become active agents with control over their access to information. For communities, the networks promote economic development by improving environmental quality, upgrading worker skill levels, enhancing a sense of identity, and decreasing dependence on distant corporations. The networks are also introducing political accountability by raising in key public forums the issue of chemical company influence over pest control. For example, BIRC, aided by other CASA organizations, organized a round table on this topic at a meeting of the Association for Applied Insect Ecology, the key professional association of most PCAs. These discussions are leading to proposals to change the way PCAs are licensed and paid, so that they are employed by farmers to give "whole farming systems" advice, rather than having their incomes tied to sales commissions.

Other social networks slow the transition to sustainable practices. Social bonds between farmers and chemical company PCAs who live in their communities, attend their churches, and send children to the same schools are one reason cited for slow adoption of IPM. The desire not to see a friend's financial situation decline may override other considerations in a farmer's mind. In other cases, peer influence can reinforce conservatism or introduce ambivalence about the economic and production data supporting IPM. It can take many years of patient organizing efforts to build sufficient trust to counter the force of existing social networks. Relationships of trust and reciprocity can be important both in hindering sustainable agriculture and in fostering it.

Marketing Coalitions

The future of sustainable agriculture depends on expanding the market beyond the

narrow niche represented today by the organic market. Obstacles include cosmetic standards, marketing orders, price instability, and a distribution system in which farmers retain on average only 20-25% of the total value of purchased food (Smith, 1992). The remarkable expansion of farmers' markets in California, now numbering over 250, has enabled many small farmers using sustainable practices to remain economically viable. Farmers' markets also contribute to the health of local communities by serving as incubators for other businesses (Lyson et al., 1995). Local marketing campaigns in many California counties are expanding the demand for locally grown and processed foods by educating consumers, publishing seasonal eating guides, linking farmers with local restaurants, promoting farmer's markets, and other means (PlacerGROWN, 1995).

It has been more difficult to imagine marketing strategies for commodities other than fresh produce. One innovative model has been pioneered by the Sustainable Cotton Project (SCP), which does research, education, and outreach to promote cotton production and processing alternatives. SCP has created a "vertical dialogue" involving all segments of the industry, including organic cotton growers, gin representatives, textile mill managers, and marketing firms. Leaders in the clothing industry are opening markets by promoting lines of organic clothing. Two widely attended transitional organic cotton conferences brought together interested parties, provided the first compilation of agricultural extension advice for organic cotton growers, and led to the creation in 1994 of the National Organic Cotton Association. The Association promotes collaborative problem-solving on production, supply, tracking, and certification issues, and develops a broad base of consumer support.

The potential benefits of this work are great, since cotton is one of California's largest and most chemically dependent crops. Heavy use of these chemicals is of particular concern in the southern San Joaquin valley, where questions have been raised about the health and safety of farm workers and communities. Organic cotton has increased steadily over the past few years, but remains a very small fraction of the total. Since innovative cotton practices are recent, difficult technical questions are still to be worked out. The new social relationships forged by SCP make it more likely that funding and technical support will be forthcoming, since they enlarge the community of interest beyond the small group of committed farmers.

LWWC, too, has sought to build alliances that extend beyond the farming community, primarily by educating wineries about their IPM program. Most wineries have been reluctant to give special treatment or pursue special labels for grapes produced by IPM methods, in part because consumers do not recognize the meaning of IPM in the same way they do the concept of organic. Others fear that to do so would compromise the image of wine created from conventionally grown grapes.

Whether built around a place or a commodity, marketing coalitions play a key political role by checking the power of agriprocessing and marketing firms to shape food and fiber choices. By mobilizing social capital they partially offset the powerful effects of the enormous amount of money spent each year on advertising campaigns that drive home the corporate vision of cheap, convenient food. By linking quality products to environmental, social, and economic benefits, the new marketing coalitions are getting a response from citizens tired of corporate slogans and eager for a more personal connection to what they eat and wear. They also open economic space in which local food systems become more viable.

Agricultural Policy and Planning Coalitions

Another critical barrier to sustainable agriculture in California is urban sprawl and development. The state has lost 15% of its farmland since 1964 (Carter and Goldman, 1992); conversion of prime farmland is expected to increase dramatically because of a projected tripling in the population of the 10 largest agricultural counties over the next 50 years (California Department of Finance, 1993). Since sprawl threatens all farmers, coalition-building around this issue can strengthen ties between sustainable agriculture activists and mainstream farming organizations.

To spark community interest in sustaining agriculture in the face of development, the University of California at Santa Cruz's Center for Agroecology and Sustainable Food Systems (CASFS) created the Agriculture and Community Project (AgComm). AgComm engages in applied research and education in collaboration with the local community, such as public forums on the past, present, and future of agriculture around Monterey Bay.

The project began in 1992 by pulling together a nine-person planning committee representing diverse community stakeholders: Farm Bureau, Cooperative Extension, a local real estate agent, a mayor, a city council member, a church representative, a farmer, a community organizer, and an interested community member. This group met once a month for five months, then less frequently for the next year. These initial discussions stalled when the project staff person left the university, but they resumed a short time later when a grant made it possible to hire a replacement. Over a three-year period beginning in 1993, many public meetings were held, the largest of which attracted 120 participants to a session in which community members established priorities for research and community action. Farmland protection emerged as a key issue, and AgComm followed up by conducting research, organizing a tour of nearby counties with progressive farmland protection policies, and advising the Agricultural Policy Advisory Commission to the Board of Supervisors regarding agriculture on the urban edge.

While these efforts have yet to produce specific policy changes, they have built important relationships and raised community awareness of farmland issues. The AgComm staff person began regularly attending Farm Bureau meetings, helping to improve CASFS's image with local farmers. Maintaining these community relationships has become a more integral part of how CASFS sees its mission. Teaming up with Cooperative Extension, AgComm held a National Issues Forum on the topic of farmland protection that attracted 50 participants, including most of the community's influential power holders. A group of 25 to 30 forum participants still meets regularly, despite the end of the initial grant to AgComm and the need to rely on volunteer support for staffing and facilitation. The commitment of this group to carry on without paid staff, and the strength and diversity of its membership, suggest that the slow

process of coalition building is beginning to generate increased social capital. Whether this will lead to tangible policy changes remains to be seen.

Farmworker Support Center

Inflation-adjusted wage rates for California farm workers have fallen by 10% over the last decade (Zabin et al., 1993), and working conditions are poorer than in most other industries. Unable to obtain secure, year-round employment at living wages, farm workers and their families often require support from public service budgets and are seen by many as a burden on the community (Vaupel, in press). The farm worker support network initiated in 1985 at the Rural Development Center (RDC) in Salinas demonstrates that the farm labor force could just as easily be seen as an underutilized community asset awaiting proper development.

The RDC combines aspects of a grower information network, marketing coalition, and training program, all focused on the goal of establishing farm worker families as independent farmers. The RDC promotes self-reliance by helping people gain skills and experience they need for starting their own farming operations or seeking more stable employment. Through a collaborative relationship with the University of California, the Center conducts research and outreach on sustainable production practices. For its farm worker constituency, whose experience is predominately with conventional agriculture, the education opens the possibility of a different way of farming. A recent survey documented that 78% of the 60 families completing the center's three-year training program now farm on their own as their principal livelihood (Baier, 1994).

The RDC has become more than just a support network for farmer-to-farmer information exchange. It actively integrates families into its work. For example, the training program involves not only the farm worker, but also spouses and children. A recently started youth garden project has brought Salinas-area students to the RDC site for training and field projects. The RDC leadership is committed to expanding the web of community connections, especially those involving women, children, and youth.

Discussion

To reach its multifaceted goals, the sustainable agriculture movement must be more effective in holding concentrated power accountable, must unify its environmental and social agendas, and must foster and sustain leadership that combines sound analysis, political savvy, and sensitivity to its community base. The CASA projects just described show how a political strategy emphasizing a vision of community-controlled economic development might significantly aid the movement in meeting these difficult challenges.

Holding power accountable

Paarlberg (1995) has argued that the fundamental cause of resource abuse in agriculture is abuse of power, rooted in relationships that allow the few to pursue gain without accountability to the many. Advocates of sustainable agriculture have challenged these relationships by organizing to influence the Farm Bill and other public policies at the national and state levels. There are problems, however, with making this the exclusive or primary political strategy. The decision-making arenas in which these battles are fought are well defended by established interests, making organizing efforts costly, difficult, and occasionally futile. The currencies of power that matter in these arenas, money and prestige (often measured by the perception that one's business is critical to the health of the Gross National Product), are not movement strengths.

By contrast, CASA's networks employ community organizing strategies to alter power, drawing on resources in ample supply: credibility, personal relationships, and a shared commitment to place. The most successful organizing efforts nurture and exploit each of these strengths in several ways: by developing analytical capabilities that make them a regular and trusted source of information; by taking the time to build personal relationships, rather than imposing a set program of ideas to be disseminated impersonally; and by identifying common interests and consensus approaches whenever possible.

While focusing few resources and little energy on explicit efforts to "change public policy," CASA organizations nevertheless challenge key power relationships. Grower information networks free farmers from dependence on "experts" with strong ties to agribusiness, and link them instead to neighboring farmers and to sources of technical advice that they themselves control. Marketing coalitions carve out niches in which farmers and citizens can be linked more directly and deliberately, allowing social values to take their rightful place alongside commercial concerns. Agricultural planning and policy coalitions raise community awareness and check the power of developers over local decision makers. Farmworker support networks empower those who are least powerful in the current system, changing them from perceived liabilities to community assets.

The effectiveness of these efforts can be enhanced if they become less isolated. Greater cohesiveness would enable organizations to learn from one another's successes and failures, avoid duplication of efforts, forge strategic alliances, and provide a grassroots base for changing public policy. Yet CASA has struggled to identify collaborative projects to achieve these ends. In part, this was due to the difficult nature of the collaboration, which brought together groups with pre-existing conflicts and with accountability to different and sometimes directly conflicting interests and constituents. But it also was due to lack of a shared strategic vision that could integrate these constituencies behind a common agenda. The promise of community-controlled economic development is that it provides a conceptual umbrella under which pesticide reduction, labor, farmland protection, and related issues are components of a single organizing effort, rather than isolated issues, each with a separate politics.

Unifying environmental and social agendas

Policy-making processes at the national level tend to separate sustainable agriculture's environmental and social agendas, fitting them into distinct and often conflicting niches. The resulting policies, along with competitive market pressures, have made input substitution and improved production techniques a much higher priority than improving labor conditions, preserving farmland, eradicating hunger, or aiding rural

communities. In this political setting, the effort to address social issues is often viewed as counterproductive, since it threatens farm profits and weakens political support for environmental policies. When the focus is community problem-solving rather than the inherently adversarial budgetary and regulatory processes of government, greater opportunities exist to integrate environmental and social concerns (Kemmis, 1990; Ostrom, 1990; Putnam, 1993). A shared commitment to a place and the expectation of continuing encounters tend to check behavior that deviates from shared community interests and to subsume separate issues under a broader concern for the community's welfare.

In its initial deliberations about how to allocate resources, CASA's steering committee found it difficult to reconcile the competing agendas of its member organizations, which ranged from outspoken advocates of social issues to mainstream farmers interested primarily in pesticide reduction. Early meetings were conducted in the spirit of a formal budgetary hearing. But as trust developed during three years of monthly meetings and other joint activities, bridges were slowly built. Discussions between the LWWC's Executive Director and other members of the CASA steering committee led LWWC to hold IPM training sessions for farm workers, which has increased their skills and earning potential while also benefiting employers. AgComm's work on farmland protection gave greater credibility and visibility to its report on farm worker housing and to CASFS's research on organic agriculture. The Sustainable Agriculture Research and Education Program worked with other CASA organizations to link farmers with low-income residents under the rubric of "community food security." By the end of the grant, the steering committee made a unanimous decision to allocate scarce funds to the RDC for minority outreach programs. The point is not that environmental and social concerns are always easily resolved at the community level. But when stakeholders representing these interests are brought together in contexts that highlight their common interest in a healthy community, consensus on concrete initiatives is made more probable.

Fostering collaborative, community-based leadership

Integral to the success of each of the CASA networks are creative and hardworking leaders. The networks train new movement leaders and strengthen the influence of existing ones. For example, the RDC currently is directed by one of its former students, who now serves on important state and national boards and policy committees. Lodi grape growers have developed a strong sense of cohesion and have enhanced their community's sense of identity. Because local political leaders view them as "doing the right thing" regarding chemical use at the urban interface, regulatory issues such as water quality are resolved with less time and difficulty. CAFF and BIRC leaders, once considered on the "environmental fringe," have become part of an established network of university and governmental representatives. A series of leadership training seminars sponsored by CASFS has extended the CASA experience to emerging community-based leaders.

But these successes have yet to translate into a common, shared leadership that can overcome the competing agendas and turf battles that still divide California's sustainable agriculture organizations. Despite having ample funds to support a major collaboration, CASA often failed to find consensus, and resorted to "dividing the pie" among participating organizations. This tendency diminished gradually over a three-year period, as experience in working together led to greater trust and formation of "mini-collaborations" to work on projects of common interest. By the third year of the collaboration, after gaining experience in tackling tough issues and developing skills in group process, the steering committee finally agreed on a joint project: creating a "Call to Action" for the California sustainable agriculture movement. This document will be useful to heighten awareness of the need for movement organizations to collaborate on policy goals, but it falls short of outlining a coherent strategy for how this will be accomplished.

Conclusions

If it is to build on its achievements and advance to a new level of unity and influence, the sustainable agriculture movement must transcend the limits of interest-group environmentalism. Its new form will be more akin to the recurring populist insurgencies in which farmers have challenged elite abuse of power and the hold of industrial values over American culture (Goodwyn, 1978; Kemmis, 1990). This transformation will require a "sociological imagination" comparable to the imaginative production practices of creative farmers. As Mills (1959) describes it, the fruit of this imagination is the ability to turn private "troubles" borne individually into public "issues" advanced by groups that define common problems and shared interests. Successful democratic movements create institutions within which prevailing social ideas and power relations are called into question and new initiatives forged (Boyte and Evans, 1986).

The CASA experience shows that the sustainable agriculture movement is creating these "free spaces." On the other hand, it has yet to produce a coherent strategy that articulates in simple terms what the movement's diverse community-based organizations have in common and why they should work together at the local, regional, state or national levels. The concept of community-controlled economic development can unite the movement around building community food systems that nurture cooperative relationships while enhancing economic self-reliance. The result can be a more cohesive and compelling political strategy, one that establishes sustainable agriculture as a vital ally of communities battling economic dependence and of citizens seeking satisfying face-to-face encounters where shared problems are identified and solutions discovered. In our increasingly cynical age, providing such encounters contributes not merely to the movement's explicitly stated goals, but to the common quest for vital civic life.

Acknowledgments. Many thanks to my colleagues on the CASA steering committee, who provided detailed information and supported my research as part of its three-year, Integrated Farming Systems grant from the W.K. Kellogg Foundation. CASA member organizations include: The Bio-Integral Resource Center, California Adolescent Nutrition and Fitness Program, Center for Agroecology and Sustainable Food Systems, College of Natural Resources at UC Berkeley, Community Alliance

with Family Farmers, Lodi-Woodbridge Winegrape Commission, Rural Development Center, Sustainable Cotton Project, and the UC Sustainable Agriculture Research and Education Program. For their helpful comments on earlier drafts of this paper, I thank Jill Auburn, Bob Bugg, Mark Chandler, Dave Chaney, Sheila Daar, Gail Feenstra, Dan Goldrich, Dale Hess, Chuck Ingels, Jose Montenegro, Kerstin Ohlander, and Judith Redmond.

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New CRP Rule Will Increase Eligibility

Final regulations recently announced by the USDA will increase the number of acres eligible for the Conservation Reserve Program, and increase the number of acres the program protects from 32.9 million acres to 36.4 million acres, according to the USDA. The CRP is a voluntary program that allows landowners to place environmentally sensitive cropland in long-term conservation practices. "The final rule greatly increases the amount of cropland eligible for CRP, a blow to improved environmental targeting," said Ferd Hoefner of the Sustainable Agriculture Coalition. "The land the USDA has added for eligibility is land that can be farmed sustainably and productively—they would be taking it out of farming and retiring it."

The Nature and Properties of Soils. 11th edition. By Nyle C. Brady and Ray R. Weil. 1996. Prentice Hall, Inc., Upper Saddle River, NJ 07458. 740 pp. $85, hardcover.

T.L. Lyon and H.O. Buckman originally published *The Nature and Properties of Soils* in 1922. Although they probably felt they had written an excellent book, it is unlikely that they or anyone else in 1922 ever considered that 75 years later it would still be an extremely popular and widely used introductory soils textbook. It has remained popular because it has consistently been well written, comprehensive, and topical. The 11th edition by Nyle C. Brady and Ray R. Weil continues this tradition.

The strengths of the 11th edition are numerous, even in comparison to the very good 10th edition (published in 1990). The 11th edition is an especially comprehensive, science-intensive textbook that is remarkably easy to read. The twenty chapters explain (in decreasing order of emphasis) the edaphological, pedological, and environmental aspects of soil in a logical, reader-friendly way. The writing style and level are very appropriate for an introductory textbook, and discussions generally are up-to-date, which is a real compliment when one considers how much soil science has changed over the past few years.

Coverage of many topics occurs through three complementary approaches: traditional text; liberal use of well-annotated tables, figures, and photographs; and boxed overview explanations of especially important points. Even now, the esthetic and informative qualities of the figures and photographs keep me leafing through the book, which indicates that the authors wrote this edition very well, because I already am familiar with all the topics in the book and have used the 10th edition three times in teaching an introductory soils course.

The drawbacks of *The Nature and Properties of Soils* are few, but potentially significant. First, the $85 price is hefty. Second, the book is not oriented toward alternative agriculture. This is illustrated by its discussion of soil quality. Soil quality is mentioned in three chapters (Chapter 11, Organisms and Ecology of the Soil; Chapter 12, Soil Organic Matter; and Chapter 16, Practical Nutrient Management), yet each time the discussion is peripheral and brief. Perhaps even more frustrating was the absence of any definition of soil quality in the text or in the Glossary of Soil Science Terms. A third drawback is the occasional technical error. These are most common in the chapters based on pedology, and probably arise as the authors inadvertently perpetuate ideas that have been or are being discarded by researchers outside their specialties. An example is the focus on montmorillonite in Chapter 8 (Soil Colloids: Their Nature and Practical Significance). Readers would be far better served to learn only about smectite (a mineral group that includes the montmorillonite species) because, contrary to what the authors write, montmorillonite is not always the most prominent smectite mineral.

In summary, *The Nature and Properties of Soils* is an excellent introductory soil science textbook. Its weakest area is alternative agriculture. Consequently, people interested in alternative agriculture will be best served by this book if they use it as a reference in the context of a variety of other information.

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Pest Management at the Crossroads. By Charles Benbrook, with Edward Groth III, Jean M. Halloran, Michael K. Hansen, and Sandra Marquardt. 1996. Consumers Union, 101 Truman Ave., Yonkers, NY 10703. xii+272 pp. ISBN 0-89043-900-1. $35.95, paper.

There is no question that synthetic chemical pesticides, which were introduced in the 1940s and are now used widely on agricultural crops, have their share of unintended consequences. Widespread evidence exists on pesticides' adverse impacts on nontarget organisms like beneficial insects, birds, mammals, and even humans. Instead, the question is whether or not we have reached a fork in the road—a point where the secondary problems associated with pesticides have cut into the chemicals' effectiveness, and a point where the social costs of using some chemical pesticides now outweigh their benefits. If we are at this fork, the problem becomes recognizing it and picking the correct path. The Consumers Union book *Pest Management at the Crossroads* discusses this fork in the road from many angles and suggests a road map for what the authors feel is the appropriate path. *Pest Management at the Crossroads* is the work of lead author Charles Benbrook, the former executive director of the Board on Agriculture of the National Research Council (NRC), and four colleagues from Consumers Union and Mothers and Others for a Livable Planet.

At the book's core (Chapters 2 and 3) is the thesis that our society is on a pesticide treadmill where aggregate risks have not declined despite the widespread use of new highly active, low dose pesticides and despite 25 years of pesticide regulation. The authors back up this startling claim by using the Environmental Protection Agency's previously unavailable datasets to estimate risk trends based on pesticide usage data and mammalian toxicity scores. Their analysis shows that there has been little overall reduction in the acute and chronic toxicity of all agricultural pesticides—insecticides, herbicides, and fungicides—taken as a whole, from 1971 to the present. A decrease in the chronic toxicity of insecticides is one of the few individual success stories over this 25-year period. This type of trend analysis has not been previously attempted and, given the nature of the results, will likely be met with some skepticism. In hindsight, it would have been useful if these findings had first appeared in a peer-reviewed journal in order to establish their authenticity and pre-empt the skeptics.

With the pesticide treadmill documented, the book moves on in Chapters 5, 6, and 7 to outline a solution: accelerated progress toward biointensive integrated pest management (IPM) to get off the treadmill. Here Benbrook and colleagues return IPM to its founding principles, which assert that biological controls can be manipulated to increase their effectiveness,

and that (reduced risk) pesticides should only be used when natural control processes fail. This solution echoes the conclusions from a recent NRC book, *Ecologically Based Pest Management: New Solutions for a New Century*. However, the authors carry biointensive IPM a step farther by providing a working definition, which is then used as the basis for establishing a baseline and setting policy goals. Under this definition, only about 31% of cropland is currently managed under "High" or "Medium" biointensive IPM. *Pest Management at the Crossroads* proposes as a national policy that the cropland in biointensive IPM should double by the year 2000, that 75% should be in High or Medium by 2010, and that essentially all of American agriculture should be in High IPM by 2020.

Realistically, can these goals be met? To do so would at the very least require a reorganized research and education infrastructure, a breakdown of institutional barriers, and a coordinated public-private partnership to lead the way in promoting biointensive IPM, not pesticide use. This is the policy prescription, or road map, that *Pest Management at the Crossroads* suggests in Chapter 9. For example, the book suggests that current efforts like the U.S. General Service Administration's indoor and urban IPM program or the Campbell Soup Company's program for minimizing pesticide use by its contract growers be used as models. It also suggests that consumer demand may help lead the way if products could be marketed under an easy to understand "IPM-grown" label, or if large retail enterprises like Pizza Hut were to announce that they will buy only IPM-grown tomatoes for their tomato sauce.

Building a biointensive IPM infrastructure will require a great deal of information exchange and outreach. Surely the information superhighway will help. To this end *Pest Management at the Crossroads* lists 44 World Wide Web addresses that contain information on pests, pesticides, pesticide alternatives, and agricultural policy. These sites, which include such diverse entities as Pesticide Action Network North America, the American Crop Protection Association, and the Pesticide Properties Database, are sprinkled throughout the text.

Pest Management at the Crossroads takes a bolder position than NRC's *Ecologically Based Pest Management*. For example, both describe elements of USDA's boll weevil eradication program, but they leave the reader with two different conclusions. The NRC book stresses the success of the eradication program when used in conjunction with IPM (it cites as evidence the 1994 Georgia cotton crop, which was the highest since 1935). In contrast, *Pest Management at the Crossroads* stresses the failure of the eradication program when used without IPM practices (it cites as evidence the Texas cotton crop failure following the 1995 approval of a new eradication zone in the Lower Rio Grande). It is more critical of the eradication program, yet like the NRC book it is well supported with plenty of references and documented evidence.

Pest Management at the Crossroads is packed with information, yet still manages to present its case in an understandable and well-organized framework. It contains an executive summary and nine chapters, each clearly outlined with headings, subheadings, and bullets for key points. The text is full (perhaps a little too full) of pictures, figures, graphs, tables, and pull-out quotes. Overall, *Pest Management at the Crossroads* might be the best book available for learning about pest control, pesticide risks, IPM, and pest-management policy.

Edward C. Jaenicke, Policy Analyst, Henry A. Wallace Institute for Alternative Agriculture, Greenbelt, MD 20770.

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Food Protection Act Will Promote "Safer, Effective Pest Control"

The Environmental Protection Agency's plan for implementing the 1996 Food Quality Protection Act is based on five guiding principles that include "promotion of safer, effective pest control methods," and "a protective, health-based approach to food safety." The Food Quality Protection Act requires major changes in how the EPA regulates pesticides, includes new food safety protections, and requires the EPA to address new considerations in establishing tolerances for pesticide residues in food. Those considerations include assessing total pesticide exposure from all non-occupational sources, and assessing the effects of exposure to multiple pesticides with a common mechanism of toxicity.

The major provisions of the new implementation plan include establishing a single health-based standard for all pesticide residues in food, whether raw or processed; requiring the EPA to reassess roughly 9,000 existing permissible pesticide tolerance levels in food to ensure they meet the new standards; requiring the EPA to develop consumer information on the risks and benefits of pesticides used in or on foods, as well as recommendations to consumers for reducing dietary exposure to pesticides while maintaining a healthy diet; and ensuring that all pesticides will be periodically re-evaluated to make sure they meet current testing and safety standards.

The implementation plan is available from the Office of Pesticide Programs Public Docket at (703) 305-5805, and on the Internet at http://www.epa.gov/pesticides/lawsregs.htm.

INSTITUTE NEWS

Wallace Had "Second Thoughts" About His Agricultural Revolution, Says Kirkendall

Henry A. Wallace promoted "an American revolution" of institutional and technological change which "transformed the ways of farming, the farm population, and the agricultural system" — and also caused him to have second thoughts during the last years of his life, according to Dr. Richard S. Kirkendall, who recently presented the 1997 Henry A. Wallace Annual Lecture. Dr. Kirkendall, the Scott and Dorothy Bullitt Professor of American History at the University of Washington in Seattle, has devoted a considerable part of his research and writing to the life and philosophy of Wallace and the Wallace family.

His speech, entitled "Second Thoughts on the Agricultural Revolution: Henry A. Wallace In His Last Years," quoted Wallace as saying, "I fear we may be headed even in the Corn Belt for Big Agriculture as well as Big Labor and Big Business and Big Government." Although supportive of the family farmers who had adopted the new ways of farming, "Henry worried that the demographic component of the revolution would seriously damage the national character," Dr. Kirkendall said.

Wallace believed that "farm habits" had been "the strength of the U.S.," which led him to ask, "How long can a civilization exist with less than eight percent of the next generation acquainted with the virtues inculcated by farm living?" It was this idea about "the importance of 'farm habits' for the national character that persuaded Henry to press once again for a substantial farm population. As he saw things now, this national need for people on farms meant that small farmers should be held on the land." The solutions that attracted Wallace's attention were part-time farming and industrial decentralization, according to Dr. Kirkendall. Wallace even met with President Lyndon Johnson about the need for a "program of decentralization of industry so that most of the smaller and more inefficient farmers may be in commuting distance of a job in town."

"Henry A. Wallace's idea of an alternative agriculture emphasized the expansion of part-time farming, not technological change," said Dr. Kirkendall. "His alternative could serve his enthusiasm for the psychological benefits of living on farms without threatening the modern farming in which he also believed. The nation, he maintained, needed both the new ways of using the land and a large population living and working on it. The modernization of farming had sharply reduced the percentage of Americans who experienced farm life, but Henry proposed a way of turning the movement of the farm population around that would not overturn the modern farming system and its practices."

Wallace Institute Elects Officers, Installs Four New Members

The Wallace Institute Board of Directors has elected new officers for the coming year and installed four new members. The new President is **Dr. Frederick Kirschenmann**, farmer and manager, Kirschenmann Family Farms, Windsor, N.D.; Vice President is **Dr. Cornelia Butler Flora**, Professor of Sociology and Director, North Central Regional Center for Rural Development, Iowa State University; Secretary is **Dr. Frederick Magdoff**, Professor, Department of Plant and Soil Science, University of Vermont; and Treasurer is **Jose Montenegro**, Director, Rural Development Center, Salinas, CA. The new members of the board are **Desmond A. Jolly,** Agricultural and Consumer Economist, Department of Agricultural Economics, University of California, Davis; **Deborah A. Neher,** Assistant Professor, Department of Biology, University of Toledo; **Robert I. Papendick,** Professor Emeritus, Department of Crop and Soil Sciences, Washington State University; and **Frederick V. Payton,** Assistant Professor, Institute of Community and Area Development, University of Georgia.

Research Improvements Needed to Ensure Sustainable Ag, Ervin Testifies

Improvements in the public agricultural research and education system are necessary to ensure agriculture's long-term competitiveness, enhance its environmental performance, and improve rural community well-being, according to testimony given recently before the Senate Committee on Agriculture, Nutrition and Forestry by Dave Ervin, Director of the Wallace Institute's Policy Studies Program. He recommended dedicating specific funding to build an improved public agricultural research accountability system led by USDA with full stakeholder participation; targeting increased research funding for environmental and other public goods; and establishing a national commission on extension to assess innovative reforms across the country that can help safeguard the sustainability of agriculture. "Public research and education should lead the development and adoption of sustainable agriculture," he testified.

Wallace Family, Several Institute Leaders Featured in New Book

The Wallace family and several leaders of the Wallace Institute are featured in *Iowans Who Made a Difference: 150 Years of Agricultural Progress,* a 367-page book written by Don Muhm and Virginia Wadsley and published by the Iowa Farm Bureau Federation. "Iowa's Premier Agricultural Family: The Wallaces" is an entire chapter devoted to the Wallace family, beginning with "Uncle Henry" Wallace, grandfather of Henry A. Wallace. Several pages describe the accomplishments of Henry A. Wallace—Secretary of Agriculture, Vice President, and the man for whom the Wallace Institute is named. "The emergency policies he established in the Agricultural Adjustment Act, passed shortly after he took office, have served as the foundation for government agriculture programs for over 60 years." Also included in the chapter

is his daughter, Jean Wallace Douglas, the Wallace Institute's Honorary President, who heads the Wallace Genetic Foundation and "has given major support to sustainable agriculture ventures and environmental projects."

Another chapter profiles "150 Who Made Such a Difference," 150 Iowans "who have made particularly significant contributions to agriculture," including these Wallace Institute leaders:

Norman A. Berg, a current member of the Wallace Institute's President's Council and former Chief of the USDA's Soil Conservation Service, "one of the strongest advocates for wise land-use and conserving the nation's natural resources."

Paul Johnson, a former Wallace Institute Board Member and Chief of the USDA's Natural Resources Conservation Service, "the chief architect and sponsor of one of the most historic and far-reaching environmental programs ever enacted by the Iowa legislature—the 'Groundwater Protection Act' that became a national model."

Dick and Sharon Thompson, whose on-farm research receives funding from the Wallace Institute; Dick Thompson is a former Wallace Institute Board Member. "The demonstration aspect of their farm has not only played an important role in technology transfer, but it has also convinced other farmers, through positive results, that the new practices are worth attempting."

Tom Urban, a current Wallace Institute Board Member and former President, CEO, and Chairman of the Board of Pioneer Hi-Bred International, who "combined business education knowledge with knowledge of the farmer, maturing into a futuristic leader on the cutting edge of today's international business world."

Dr. Arshad Joins AJAA Editorial Board

Dr. M. (Charlie) Arshad has become a member of the Editorial Board of the *American Journal of Alternative Agriculture*, the Wallace Institute's quarterly, peer-reviewed journal of research on alternative agriculture. Dr. Arshad is a Research Scientist in Soil Physics and Management for the Northern Agriculture Research Centre, Agriculture and Agri-Food Canada, which he joined in 1984. He is also an Adjunct Professor of Soil Science, University of Alberta, Edmonton.

After working as a Soil Scientist at the Alberta Research Council and the University of Saskatchewan, Dr. Arshad spent 12 years overseas establishing teaching, research, and agricultural development programs, including work in Nigeria and Kenya. He returned to Canada in 1981 to work as a Senior Soil Scientist at the Soil Conservation Service, Agriculture Canada. His present research concentrates on soil physical, chemical and biological properties as affected by cropping and tillage practices.

In Memory of Don F. Hadwiger

After a long illness, Don F. Hadwiger, a member of the Editorial Advisory Board of the *American Journal of Alternative Agriculture*, died in January at age 66. He had been on the *Journal's* Advisory Board since its first issue. At the time of his death, he was an Emeritus Professor in the Department of Political Science at Iowa State University.

Dr. Hadwiger wrote the article on "Henry A. Wallace, Champion of a Durable Agriculture" in the *AJAA* (Volume 8, Number 1, 1993) after the Institute for Alternative Agriculture was renamed the Henry A. Wallace Institute for Alternative Agriculture. That article provided a perspective on the connections between the life and work of Henry A. Wallace and the purposes of the institution which had come to bear his name.

Hadwiger received his Bachelor of Arts degree from the University of Oklahoma, his Masters degree from the University of Nebraska, and his PhD degree from the State University of Iowa. He then taught at Southwest Missouri State College from 1956 until he joined the political science faculty at Iowa State University in 1962. During 1957-1959, he was an American Political Science Association Congressional Fellow, and in 1965-1966 was an Outside Scholar in the U.S. Department of Agriculture.

Hadwiger, a long-time student of agricultural history, concentrated his research in the field of U.S. agricultural politics and policies. He wrote several books in that area, including *Pressure and Protests: The Kennedy Farm Program and the Wheat Referendum of 1963*, *The Policy Process in American Agriculture* (both with Ross Talbot), *Federal Wheat Commodity Legislation*, and *The Politics of Agricultural Research*.

By 1970, Hadwiger had become well-recognized in the political science academy in his field of specialization. He edited, and published in, several books and symposia, often with William Browne, beginning with *The New Politics of Food*. During these years, he was also a contributor of chapters in several other policy studies books. His essay on "Agriculture Policy," in *Nationalizing Government: Public Policy in America*, became a standard reference.

He also published articles in *Agricultural History*, *Public Administration Review*, *Policy Studies Journal*, *Public Personnel Management*, *Food Policy*, *Journal of Soil and Water Conservation*, and *Technology in Society*.

Hadwiger was a member of the editorial board of the *Policy Studies Journal*, where he served as editor from 1990 to 1993. He was also a member of the editorial boards of *Agricultural History*, *Journal of the Great Plains*, *Agriculture and Human Values*, and *American Review of Political Science*. He was also an active organizer and participant in numerous professional panels and symposia.

"Don was an ardent believer in the proposition that a political scientist should involve his expertise in the ongoing political life of his community, state, and nation," the *Policy Studies Journal* wrote after Hadwiger's death. "He didn't love or seek controversy but he certainly was willing and able to enter the public arena when he decided, as he did often, that it was his civic and professional responsibility to do so."

Guide for Authors

The American Journal of Alternative Agriculture (AJAA) publishes original research on biological, physical, or social science aspects of alternative agriculture. We particularly welcome multidisciplinary studies, but papers from a specific discipline also are invited. However, since AJAA readership is much broader than for a single-discipline journal, highly specialized terminology should be explained or avoided. The significance of a statement, or the reasoning behind a conclusion, may have to be spelled out more than in a more specialized journal. See Vol. 5, No. 1, pp 2 & 3, for an explanation of the various categories of articles.

Units

Research papers should use the International (SI, or metric) system throughout. Occasional use of common unit equivalents in parentheses is permitted.

Title page

The title page should give the following information (all flush left): 1) title of the paper; 2) names of authors; 3) affiliation and office address of authors, and 4) disclaimers and publication number, if any. See examples in this issue of AJAA.

Abstract

The abstract should be 200 to 400 words suitable for readers from a broad range of disciplines. It should avoid highly-specialized terminology that might be appropriate for a single-discipline journal. Take particular care that the significance of the work is made clear, even to readers from a different field.

Key words

Provide subject matter key words suitable for use in scientific indexing.

Reference list

When citing material that has been covered in more than one format, such as the typescript of a conference presentation and a journal article, preference should be given to the version that is most readily available, and that is likely to remain so. Generally this means standard publication channels, such as books, journals, and regular government report series. Unpublished or informally-published material should be cited only when no alternative form exists.

References should be listed in alphabetical order by author's name, and by year for a particular author (with letters after the year if needed). If a sole author is also the lead author of papers with multiple authors, use the following order: single author (by year); two authors (alphabetically by second author's name); three or more authors (by year). Repeat the author's name for each reference. Give the names of all authors in the reference; never use "et al."

Use full names of journals, institutions, conferences, etc., except for extremely familiar abbreviations like "Dept." Remember that an abbreviation familiar to you may not be familiar to readers outside your field. If in doubt, write it out.

The reference list uses no quotation marks, italics, boldface, or underlining. Only the names of books and periodicals are in initial capitals. Names of papers, book chapters, pamphlets, and bulletins are not capitalized.

Citing references

Cite references in the text by last name and year, with chapter or page numbers if the reference is a book or lengthy report. For two authors, give both names. Do not use "et al." unless there are at least three authors.

Footnotes

AJAA does not use bibliographic or substantive footnotes. All bibliographic references should be at the end of the text. Instead of substantive footnotes, include the material in the main text or consider eliminating it.

Manuscript preparation

The entire manuscript, including abstract and references, should be typed on one side of standard-size paper, double spaced, with margins of at least one inch all around. Starting with the title page, label all pages in the upper righthand corner with the lead author's last name and the page number. Do not use hyphens unless the hyphen is part of the word.

Tables should fit on one page, be numbered consecutively with Arabic numerals, and be on a separate sheet. Every figure and table should be mentioned at least once in the text.

A detailed guide to formatting is availabie from the editor (address below).

Submission of manuscripts

Submit four high-quality copies to William Lockeretz, Editor, American Journal of Alternative Agriculture, School of Nutrition Science and Policy, Tufts University, Medford, MA 02155. The cover letter should state that the manuscript is an original contribution that has not been published elsewhere in substantially the same form, that it is not currently under consideration elsewhere, and that permission has been obtained for any copyrighted material used.

How you can help support the scientific and educational needs of a sustainable agricultural system

A growing number of Americans have become concerned about the long-term sustainability of our food production system. Farmers and agricultural scientists are among those raising questions about the growing dependence of modern farming on nonrenewable resources, the depletion of our resource base through soil erosion, and heavy reliance on chemical fertilizers and pesticides. Continued heavy reliance on farm chemicals is questioned because they have become an expensive production input. Their widespread use also raises questions about human and animal health, food quality and safety, environmental quality, and the continued demise of the family farm.

Low-input alternative farming methods address these economic and environmental challenges. Alternative production systems point the way toward more profits, more individual choice, and long-term sustainability for our food system. More must be done to develop effective ways to make sure research, education, and information sources are readily available to farmers who want to adopt these techniques.

The Henry A. Wallace Institute for Alternative Agriculture needs your help in meeting this challenge. We are a nonprofit tax-exempt research and education organization established in 1983 to encourage and facilitate the adoption of low cost, resource conserving, and environmentally sound farming methods. We work directly with government agencies, colleges and universities, producer groups, and other institutions that provide research, education and information services to farmers.

The Wallace Institute also provides these services:

- *A resource to lawmakers and others who influence agricultural research, education, and information policy*
- *A voice for alternative agriculture in Washington*
- *A sponsor of research and education outreach programs*
- *A national clearinghouse for information on alternative agriculture*
- *A publisher of reliable scientific information on agricultural sustainability*

If you're interested in helping us, please contact the Henry A. Wallace Institute for Alternative Agriculture, 9200 Edmonston Road, Suite 117, Greenbelt, Maryland 20770-1551. The phone number is (301) 441-8777.

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